TDS-90-07

Understanding Urban Travel Growth in the Greater Toronto Area: Volume III

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Abstract: This report presents a simplified model of travel demand for the Greater Toronto Area (GTA) which is developed based on relationships observed in the 1986 Transportation Tomorrow Survey (TTS) database. This model is used to explore the likely travel demand implications of a range of land use scenarios, which include: a "base" case forecast; a "centralization" scenario; a "densification" scenario; and a "self-containment" scenario. The results from these four forecasts are compared and assessed in terms of their implications concerning the impact of future demographic and land use trends on transportation needs within the GTA.

Comments: Volume III (of 3 volumes) of the final report of Research and Development Branch Project 25194.

Key Words: future scenarios, future travel needs, sketch planning in the GTA

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EXECUTIVE SUMMARY

The purpose of this study is to investigate travel demand relationships within the Greater Toronto Area (GTA) using the 1986 Transportation Tomorrow Survey (TTS) as the database for this investigation. Specific tasks involved in the study's terms of reference include:

1. an analysis of relationships for road and transit trip-making throughout the GTA as a function of demographic and other relevant variables;
2. a literature review of urban trip-making behaviour and trends in other cities, in comparison with the GTA; and
3. the determination of trends in future road and transit needs (provincial and municipal) in various regions of the GTA, by looking at a number of factors, including the application of trip-making relationships.

Thus, the study represents an attempt, first, to achieve a better understanding of travel behaviour within the GTA, and, second, to use this understanding as a basis for the development of new transportation policies relating to this extremely important urban region.

This is the third in a three-volume set of reports documenting the work undertaken as a part of this study. The first two volumes deal in detail with the empirical analyses of the TTS database which were undertaken to achieve an understanding of current travel behaviour within the GTA. Specifically, Volume I [Bailey, et al., 1990] presents a detailed descriptive analysis of the temporal, spatial and modal patterns of work trip commuting into the central area of the City of Toronto. Volume II [Miller, et al., 1990] presents a similarly detailed analysis of trip generation relationships within the GTA, for both work and non-work purposes, with respect to a range of demographic and spatial explanatory variables. Chapter 2 of this report briefly summarizes the findings presented in Volumes I and II. In general, however, this report does tend assume that the reader is familar with the contents of Volumes I and II (particularly Volume II), and the reader certainly is referred to these two volumes for further details concerning their contents.

The focus of this penultimate report in the series is the development and application of a "scenario-based" or "sketch-planning" model of GTA travel demand which can be used to explore the likely implications of alternative assumptions relating to future trends and/or transportation policies for future travel demand within the GTA. This model derives directly from the empirical

work presented in Volumes I and II, as well from additional work presented for the first time within this volume. Important features of this model include:

1. It is based on observed travel behaviour as captured within the 1986 Transportation Tomorrow Survey (TTS) database. In general the model assumes that the 1986 behavioural relationships will hold in the future, although scenarios incorporating alternative behavioural assumptions could be implemented, if desired, within the model.

2. It explicitly incorporates demographic factors (age-sex profiles of the resident population) -- and the evolution of these factors over time -- into the travel demand calculations. In particular, labour force participation rates, work trip rates, work trip modal choice, and non-work trip rates by mode are all functions of the gender and/or age of the trip-makers involved.

3. It explicitly incorporates spatial factors (level of urbanization) into the calculations. A measure of "urban density" is used to categorize TARMS zones. Labour force participation rates, demographic profiles, work trip modal choice, and non-work trip rates by mode all depend on this term.

While in principle virtually any element of the model's input data and/or underlying behavioural assumptions could be altered within the specification of a future scenario to be tested, in this study only scenarios involving the spatial redistribution of the future growth in population and/or employment were examined. In particular, four scenarios were considered:

1. the base case, defined by current MTO projections of population and employment by TARMS zones for the years 2001 and 2011;

2. a "centralization" scenario, in which the base case projected growth in population and employment is redistributed so as to increase the growth within Metro Toronto and proportionately decrease the growth outside of Metro Toronto;

3. a "densification" scenario, in which the base case projected growth in population and employment is redistributed within each regional municipality within the Greater Toronto Area (GTA) so as focus this growth within existing "urbanized" areas, with proportionately less growth occuring in currently rural or lower density areas; and

4. a "self-containment" scenario, in which the base case projected growth in Metro-based employment is reallocated so that more employment growth occurs in the non-Metro regions within which the larger proportions of population growth are projected.

Analysis of the base scenario results leads to the following observations:

1. Considerable increases in both auto and transit usage are projected, but particularly in auto usage. These increases result both from increased population and employment levels as well as from increased trip rates per person (particularly auto work trip rates).

2. The largest gorwth in trip-making is projected to occur in the regions of York and Peel, but significant growth is expected to occur in the other regions as well, including Metro.

3. Much of the growth (62% of work trip flows) in travel is projected to be intra-regional in nature. A significant portion of the growth, however, involves two-directional "cross-boundary" trips between Metro Toronto and the surrounding regions (little inter-regional interaction among the non-Metro regions is projected).

4. A significant majority of the growth in both intra-regional and cross-boundary trips is expected to be auto-based.

5. A numerically large increase in cross-boundary transit trips is also projected. The increase in intra-Metro transit trips is relatively modest (20,000 work trips per day) compared to the current magnitude of TTC ridership. The projected growth in non-Metro intra-regional transit trips may, in some cases, be large relative to current transit usage levels. In particular, the projected transit usage assumes increases in intra- and inter-regional transit services which are commensurate with the projected increased levels of urbanization throughout the GTA.

6. The 1986-2001 period is projected to experience higher growth rates than the 2001-2011 period, both due to a projected slowing in population and employment growth during the latter period and due to a reduction in per capita trip rates (due to demographic shifts, etc.) as well.

The centralization scenario is projected to result in a significant reduction in the total number of auto trips generated within the GTA combined with a significant increase in the total number of transit trips made. The net decrease in auto trips, however, is the result of an even larger decrease in auto trips outside of Metro combined with a significant increase in auto trips being generated within the Metro boundaries. Similarly, the transit increase largely consists of intra-Metro trips, although cross-boundary transit trips also increase by a modest amount, and the decline in non-Metro intra-regional transit trips is not proportionately as large as in the auto trip case. Thus, this scenario may result in a more "efficient" transportation system (higher transit usage, fewer long distance auto trips), but it involves introducing significant additional loads on the already heavily loaded Metro transportation system (particularly the road network). Thus, the technical feasibility of this form of future development requires careful scrutiny.

The densification scenario is projected to have virtually no impact on work trip commuting patterns or modal usage. It is projected to have a significant impact on non-work travel (reduced auto trips, modest increase in transit trips), but this result requires further investigation before being accepted at face value given the very simplistic treatment of non-work modal split in the current version of the model.

Finally, the self-containment scenario as tested in this study appears to accomplish relatively little. It generates only a very modest increase in the amount of "self-contained" intra-regional work trip commuting, while at the same time it actually increases the amount of out-commuting from Metro relative to the base case. It also results in a more auto-oriented travel pattern than the base case and is projected to actually generate a small reduction in work-based TTC travel. It appears that even more population growth in the non-Metro regions than that projected by the base case (and hence a proportionately smaller population growth within Metro) would be required to achieve significant increases in self-containment relative to that achieved by the base case.

All three scenarios examined involve relatively large (and perhaps politically and/or economically infeasible) redistributions of current best estimates of the GTA's development trends. Certainly considerable effort (and cooperation) on the part of governments at all levels (local, regional, provincial) would likely be required to effectively implement any of the alternative scenarios required. The purpose of this study is not to promote any one of these alternative scenarios as desirable public policy. Rather, it is simply to explore the transportation implications of alternative land use configurations within a "what if" experimental framework, in order to provide some additional inputs into the policy formulation process.

Regardless of the land use scenario considered, if the overall levels of population and employment growth projected for the GTA through to the year 2011 are at all reasonable, then clearly significant increases in trip-making activity can be anticipated to be added to an already heavily loaded transportation system. This is particularly true of the road system, but inter-regional transit and intra-regional transit systems (most notably, but not exclusively the TTC) will all require continuing improvement if they are to keep pace with the projected demand and if they are to provide an effective alternative to the congested road system.

Actively altering the evolution of land use within the GTA does alter the GTA-wide travel patterns, but fairly significant deviations from the base trend would appear to be required in order

to generate significant impacts. Scenario 1 ("centralization") illustrates this point in that a reallocation of 15% of the projected non-Metro growth to Metro zones is estimated to result in a reduction of more than 100,000 auto round trips per weekday by the year 2011, while increasing the number of transit round trips per weekday by about 80,000 during this same time period. These are non-trivial changes in travel demand, but at the same time the hypothesized shift in both population and employment growth patterns is also non-trivial to accomplish -- both in terms of Metro's ability to attract and absorb this increased growth and in terms of the non-Metro regions' ability/willingness to help such a shift occur.

As is also illustrated by Scenario 1, shifts in land use development may well simply shift travel problems rather than ameliorate them. For example, the GTA-wide reduction in auto trip-making projected for Scenario 1 is accompanied by an actual increase in auto travel on Metro roads. Again, the overall magnitude of development within the GTA tends to determine the overall magnitude of travel demand, and restructuring of this development, while quite possibly worthwhile in terms of producing a more efficient, effective transportation - land use interaction, can ultimately only go so far in terms of reducing the absolute amount of travel being generated.

This study did not investigate the impacts of such obviously important factors as congestion effects on auto usage (principally modal split, but also trip distribution and even trip generation can be affected by congestion), strategies for improving transit service to increase transit modal splits (particularly for non-Toronto Central Area trips), and "feedback" effects of road and transit congestion on the location and magnitude of economic activities (particularly employment, but also housing). In particular, it is may well be that the levels of auto usage projected by this model simply will not occur, because people will switch to transit, or travel to other, less congested locations, or not make the trip, or live and work in some other urban area, before making the auto trips projected here under such extreme levels of congestion.

The study also did not explicitly investigate the potential impacts of deviations from current labour force participation rates, household structures, etc., except to the extent that is captured in the "base" demographic forecasts used throughout the analysis. Clearly more detailed analyses can and should be undertaken with respect to such factors. The feeling one gets from the analysis performed to date, however, is that the impacts of changes in such factors is likely to be of somewhat secondary importance relative to heavy momentum provided to the system by the "fundamental" land use - transportation interactions and trends.

While the model as developed within this study appears to be generating useful and interesting aggregate travel projections, it is still in most respects in a very preliminary and relatively simplistic state of development. Thus, the numbers presented within this report should certainly be treated as "illustrative" rather than in way "definitive". Further, several incremental improvements to the current model should be seriously considered before it is used to investigate a wider range of scenarios or to explore any one scenario in considerably more detail. These include:

1. A better linkage between the demographic (age-sex distributions) and land use (population and employment distributions) components is required. At the moment, population shifts from one part of the GTA to another do not alter the underlying demographic profiles in the affected regions -- an overly simplistic assumption. Put another way, the specification of a scenario should involve explicit consideration of how the regional demographic profiles need to be altered to maintain logical consistency -- something which was not done in this study.

2. An improved representation of modal split is required, in particular, one which is in some way sensitive to at least simple measures of road and transit service levels so that shifts in mode splits over time can be more reasonably represented.

3. An improved work trip distribution model is required that is better able to adjust to significant shifts in population and employment distributions than the current entropy/"Fratar" updating procedure is.

4. Considerably more investigation into the measurement and role of "urban density" is required. This includes more detailed comparison of density measures versus "accessibility" measures in terms of relative explanatory powers. The concept of urban density has been found within this study to be a promising means of "quantifying" urban structure in a way which can be used to help explain spatial variations in travel behaviour, but more research is required to achieve a full understanding of the concept and its ultimate usefulness within travel demand modelling.

5. The model as currently constructed consists of a rather unwieldly Fortran 77 program resident on a large mini-computer combined with miscellaneous Lotus 1-2-3 procedures resident on a micro-computer for pre- and post-processing the model's data inputs and outputs and for generating standard tabular outputs. Ideally, the model should be "cleaned up" to make it both more user-friendly and more flexible in its applications. It also should probably be transferred completely to the micro-computer environment to enhance its portability.

CHAPTER 1

INTRODUCTION

1.1 Study Purpose

The purpose of this study is to investigate travel demand relationships within the Greater Toronto Area (GTA) using the 1986 Transportation Tomorrow Survey (TTS) as the database for this investigation. Specific tasks involved in the study's terms of reference include:

1. an analysis of relationships for road and transit trip-making throughout the GTA as a function of demographic and other relevant variables;

2. a literature review of urban trip-making behaviour and trends in other cities, in comparison with the GTA; and

3. the determination of trends in future road and transit needs (provincial and municipal) in various regions of the GTA, by looking at a number of factors, including the application of trip-making relationships.

Thus, the study represents an attempt, first, to achieve a better understanding of travel behaviour within the GTA, and, second, to use this understanding as a basis for the development of new transportation policies relating to this extremely important urban region.

1.2 Background

Travel within an urban area is characterized in terms of the number of trips made, the modes of travel used, the trip distances and times (as determined by the underlying distribution of trip origins and destinations), and the temporal distribution of these trips over the day and the week. Trips are further categorized by purpose, since it clear that not only will the frequency, timing, etc. of trips vary by trip purpose but the factors affecting travellers' decision-making will generally vary by purpose as well. Similarly, the travel-related perceptions, preferences, needs and capabilities of trip-makers (and, hence, their travel behaviour) can be expected to be related to key socio-economic characteristics such as income, age, sex, auto ownership level, etc. Finally, the selection of an actual pattern of trip-making activity by a set of individuals will depend on the level of service (travel times and costs, reliability, comfort, etc.) provided by the alternative modes of travel available to these individuals, as well as on the spatial distribution of destinations accessible by these individuals via the transportation system.

Thus, in order to achieve an understanding of the demand for transportation services one must understand, in quantitative terms, the relationships between trip-making (characterized by trip rates, origin-destination distributions, modal splits and temporal distributions, all categorized by trip purpose) and the significant explanatory factors associated with this trip-making. These factors primarily consist of the socio-economic and demographic characteristics of the travelling public, the level of service characteristics of the transportation system, and the spatial structure of the urban area. Urban spatial structure is, in turn, determined both by the transportation network which provides accessibility between points in space within the urban area and by the distribution of people and activities over this area.

A firm understanding of the demand for transportation services is essential to effective and efficient transportation planning. This is particularly the case in a growing region such as the Greater Toronto Area. Decision-makers within the GTA are faced with a wide variety of transportation issues and an equally wide variety of proposals for major investments in new transportation infrastructure which are intended to address these issues. An ability to assess the extent to which these various proposals are likely to succeed in meeting current and future travel needs obviously lies at the heart of the planning process which supports such decisions.

Until recently, travel demand analysis in the GTA was significantly hampered by the lack of good quality data concerning travel behaviour in the area. With the exception of a few localized, small surveys, no comprehensive information on travel in the GTA had been collected since 1964. The result was a gradual erosion of planners' abilities to generate reliable, policy-sensitive forecasts of travel needs within the region due to their dependence on data which were either too old (i.e., the 1964 survey data), too partial (e.g., local, small-sample surveys), or too aggregate (e.g., Metro cordon count data). Fortunately, the undertaking of the Transportation Tomorrow Survey in 1986 has significantly altered this situation for the better by providing a good, new cross-sectional database for the investigation of trip-making behaviour, the development of travel demand forecasting techniques, and, ultimately, the examination of the consequences of alternative transportation policies.

Several general considerations characterize the research approach adopted within this study. The first of these is that one cannot begin to project future trends and discuss the implications of such trends for transportation policy (the ultimate objective of the overall study) until one has a

firm understanding of past trends and current patterns and of the determining factors underlying these patterns and trends. Thus, the study proceeded in a strictly sequential fashion, with the initial emphasis being placed on the analysis and understanding of current travel demand relationships, and the generation of possible future system states only being attempted once this understanding had been achieved.

The second general consideration is that both work and non-work travel behaviour need to be investigated. Conventional planning practice focuses on the work trip, since it is of prime importance for peak-period planning purposes. Non-work travel, however, comprises a considerable proportion of total travel within an urban area, heavily affects people's attitudes towards spatial structure and the transportation system, influences their automobile ownership and usage levels, etc. Non-work travel is far more complex behaviourally than work travel, and less is known about it, particularly in practical planning application terms. The TTS data base provides considerable information on non-work travel as well and this information has been exploited as much as possible throughout the study. Hence, in general, analysis proceeded along parallel work and non-work tracks, although emphasis was still placed on the work trip analysis, given its continuing importance within the planning process.

Third, as has been noted above, travel behaviour is characterized by the number of trips made (i.e., trip rates or trip generations), the spatial distribution of these trips (i.e., origin-destination trip flows), and the modal distribution or split of these trips. One cannot assess future trends in travel behaviour, the implications of these trends for the transportation system, or the likely impact of alternative policies on these trends without understanding all three of these "dimensions" of travel behaviour. Thus, the study dealt with all three of these aspects in varying detail. However, given the overall motivation of the study, as well as resource constraints, emphasis was placed on the analysis and modelling of the trip generation component of travel behaviour, in recognition of the fundamental role which trip generation plays in the determination of overall travel demand levels.

As noted above, travel behaviour depends in fundamental ways on the characteristics of the trip-makers (their incomes, ages, auto ownership levels, etc.), on the characteristics of the transportation system (in-vehicle and out-of-vehicle travel times, etc.), and the spatial structure of the urban area within which the travel is occuring. Thus, in speaking of achieving an "understanding of travel behaviour", one is ultimately speaking of achieving an understanding of the relationships

between trip-making and these explanatory factors or variables. Much of the analysis, therefore, focused on searching for theoretically defensible relationships between these "causal" factors and the observed travel behaviour.

Of the three types of explanatory factors listed above, the one which is typically the most difficult to conceptualize and to quantify is that of spatial structure. It is, however, of considerable importance within this study, since it relates directly to questions such as the extent to which suburban travel behaviour is fundamentally different than central city travel behaviour, and the ramifications which such differences might have for transportation system development. One approach to characterizing spatial structure is to compute the <u>accessibility</u> of a given location (e.g., a residential zone) to activities of a given type (e.g., shopping) as a function of the number and attractiveness (often measured by size) of alternative locations for this activity, modified by how difficult it is to travel to these locations (typically expressed as a function of travel time). Various specific functional forms have been employed to operationalize this concept of accessibility, and the construction and use of a simple measure of accessibility was briefly explored in this study. It was found, however, that a somewhat simpler concept and measure relating to the notion of "urban density" appeared to be as useful a variable as accessibility in the modelling of trip generation and modal splits, and it is this density measure that has been employed in this study.[1]

The role of transportation level of service characteristics, although obviously of both behavioural and policy significance (especially but not exclusively with respect to modal split considerations), has largely been ignored within this study, due both to study resource constraints and due to the fact that EMME/2 road and transit network data for the GTA (which provide the best basis currently for characterizing modal levels of service within the GTA) were not readily available at the time when the majority of the analysis was undertaken in this study (i.e., summer, 1989). Thus, this study focused on the role of demographic and spatial factors on travel demand, with modal level of service being at best captured implicitly within some of the spatial factors (e.g., suburban and rural areas are assumed to have lower transit levels of service than denser urban areas). Thus, an explicit analysis of the role of transportation level of service characteristics on travel demand is left for future research efforts.

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[1] The motivation, definition and use of this "urban density" measure is discussed in greater detail in subsequent chapters of this report.

The TTS database which is the source of information on GTA travel behaviour in this study has been well documented elsewhere,[2] and readers who are unfamilar with the database are referred to this documentation for detailed descriptions and discussions of the database. In terms of the work presented in this report, however, key points to note concerning the database include:

1. it provides information on a full range of modes, trip purposes and types of travellers over a twenty-four-hour period for a randomly selected weekday for all members of the households sampled;

2. the validation process has established that work trips are well represented within the database;

3. it is also clear from the validation process that under-reporting exists with respect to non-work trips;

4. only a limited amount of socio-economic information concerning households and individual household members was collected within the survey; and

5. all trip origins and destinations are geocoded to the mid-blockface level, permitting a very precise spatial disaggregation of the data, as well as facilitating the aggregation of the data into any spatial representation desired.

At the time the work reported herein was undertaken, the TTS database was maintained on the Department of Civil Engineering's Sun 3/280 super microcomputer within the EMPRESS/32 Version 2.4 database management system. EMPRESS was thus used to access, manipulate and to export special tabulations of the data, as required by the researchers. These tabulations were then further manipulated and analyzed using a combination of SAS Release 6.03, Lotus Version 2, and Harvard Graphics on an Everex 386 20-megaherz AT microcomputer, S (another statistical analysis package) on the Sun 3/280, and special-purpose Fortran 77 programs on the Sun 3/280.

1.3 Report Organization

This is the third in a three-volume set of reports documenting the work undertaken as a part of this study. The first two volumes deal in detail with the empirical analyses of the TTS database which were undertaken to achieve an understanding of current travel behaviour within the GTA. Specifically, Volume I [Bailey, et al., 1990] presents a detailed descriptive analysis of the temporal, spatial and modal patterns of work trip commuting into the central area of the City of Toronto. Volume II [Miller, et al., 1990] presents a similarly detailed analysis of trip generation relationships

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[2] See, for example, MTO [1987a, 1987b, 1988a, 1988b] and Bailey, et al. [1990].

within the GTA, for both work and non-work purposes, with respect to a range of demographic and spatial explanatory variables. Chapter 2 of this report briefly summarizes the findings presented in Volumes I and II. In general, however, this report does tend assume that the reader is familar with the contents of Volumes I and II (particularly Volume II), and the reader certainly is referred to these two volumes for further details concerning their contents.

The focus of this penultimate report in the series is the development and application of a "scenario-based" or "sketch-planning" model of GTA travel demand which can be used to explore the likely implications of alternative assumptions relating to future trends and/or transportation policies for future travel demand within the GTA. This model derives directly from the empirical work presented in Volumes I and II, as well from additional work presented for the first time within this volume. Chapter 3 provides an overview of the model which has been developed. This model overview is supplemented by more detailed presentations of the model's base data, assumptions, etc. contained in Appendices A through H at the back of the report. Chapter 4 then presents and discusses the results of the application of this model to generate year 2001 and 2011 forecasts for a range of future scenarios. Additional, more detailed results generated by the model associated with these forecasts are contained in Appendix I. Finally, Chapter 5 summarizes the major results and conclusions of the study. It also presents a set of recommendations derived from these results which deal with both the transportation policy implications of these results and suggestions for future work in this area.

CHAPTER 2

SUMMARY OF FINDINGS FROM VOLUMES I AND II

2.1 Introduction

This chapter briefly summarizes some of the key tasks undertaken, results obtained, and implications derived from these results for the work documented in the first two volumes of this project's report series. Section 2.2 summarizes the contents of Volume I [Bailey, et al., 1990], while Section 2.3 summarizes Volume II [Miller, et al., 1990].

2.2 Volume I: Travel to the Toronto Central Area

Approximately one-fifth of all home-to-work trips in the GTA in 1986 were destined to the central area of the City of Toronto, generated by a workforce within this area of 370,000. The central area is serviced by several transportation systems, including heavy rail subway, commuter rail, a dense network of surface bus and streetcar routes, expressways, and arterial roads. Commuting patterns to the central area of Toronto now cover much of the 8700 km^2 area of the GTA. Given the considerable growth which has occured (and continues to occur) within the GTA and the attendant increase in congestion levels on the transportation system, a clearer understanding of major transportation markets such as the Toronto central area is of importance in developing transportation policies appropriate to the needs of this evolving system.

The Volume I report, therefore focused on analyzing the temporal, spatial and modal patterns of work trip commuting into the central area of the City of Toronto, specifically Planning District 1 (PD 1), using the 1986 TTS as its database. Specific topics or tasks addressed within this report include:

1. a review of the literature pertaining to central areas, their spatial structure (in particular the spatial structure of urban areas and the role of central areas within this structure), the nature of commuting flows into central areas, and models of these processes;
2. an overview of the TTS database;
3. a description of the historical pattern of growth of the GTA and its transportation infrastructure;
4. a detailed analysis of commuting patterns into Toronto's PD 1, in particular dealing with:

a) the temporal distribution of centrally destined home-to-work trips,

b) the relative importance of PD 1 as a place of work within the GTA,

c) the spatial variation in interaction between PD 1 as a place of work and the residential distribution of workers within the GTA,

d) the spatial variation in PD 1 destined trip rates by age and sex of the resident population,

e) modal split characteristics across the GTA for work trips destined to PD 1;

5. a preliminary discussion of some of the policy implications that appear to follow from this descriptive analysis.

Of the various aspects of the analysis listed above, the question of modal split characteristics received particularly detailed analysis, given the importance of modal split issues in transportation policy formulation for central areas. Five modes of travel were considered: auto drive, auto passenger, "local" transit (e.g., TTC), commuter rail, and walk/cycle modes. The distribution of the usage of each of these five modes was examined in considerable detail as a function of the residential location of the worker, as well as the worker's age and sex. Auto availability factors were also examined, as well as the nature of the spatial competition of the GO Rail and TTC modes for transit riders.

General implications for transportation policy which emerged from this analysis include:

1. Despite generally high modal splits for work trips originating within the City of Toronto and Metro Toronto, potential appears to exist for increasing the use of transit by workers living in these areas. In particular, the number of auto drivers from these origins collectively represent 75% of the peak period drivers entering PD 1. Thus, a small shift in the transit modal split for these workers would be far more significant than a much larger modal shift for workers resident outside of Metro. Further, the transit infrastructure is largely in place within Metro to cost-effectively attract and carry these new riders.

2. Similarly, opportunity exists within both the City of Toronto and Metro for "densification" of the resident labour force, which would reduce the average length of work trip commutes for central area workers and, again, encourage use of the transit or walk modes.

3. Specific travel corridors within Metro appear to be less effective or under-utilized relative to others with respect to transit usage. In particular, residential areas within the Don Valley corridor tend to exhibit lower transit usage than other, apparently comparable, areas. Consideration of potential transit improvements in such corridors

appears, therefore, to be warranted.

4. GO Rail is the primary "system of opportunity" for improving transit usage among central area workers living outside of Metro. Improving park and ride and local feeder bus access to GO stations (as well as to TTC subway stations) presumably is the best way of accomplishing this, along with increasing the frequency on the GO lines outside of the Lakeshore corridor.

5. The level of central area dependency of residential areas within Metro and, more particularly, outside of Metro vary dramatically, apparently as a function of several factors, including:

    a) the quality of transportation services to the central area (e.g., communities such as Oakville with good GO Rail access to PD 1 have a very high level of interaction with PD 1);

    b) the accessibility to good highway services (which tends to depress the level of PD 1 interaction, presumably by providing good access to a spatially wide range of employment opportunities);

    c) the type of worker (e.g., blue-collar versus white-collar) typically resident within the zone; and

    d) the specific timing of the development of the residential area relative to the development of more local employment opportunities, the cost of housing, etc. (e.g., adjacent suburban areas of apparently similar nature but which have been developed at different points in time often have quite different levels of interaction with PD 1).

2.3 Volume II: Trip Generation Relationships in the GTA

The work reported in this volume focused on trip generation relationships within the Greater Toronto Area (GTA) using the 1986 Transportation Tomorrow Survey (TTS) as the database for the investigation. The trip generation component of travel demand modelling is often taken somewhat for granted by transportation planners, probably due to the simple modelling methods used and the relatively modest data requirements of these models. Reasonably accurate forecasts of trip generation levels are, however, absolutely essential to the development of credible travel demand forecasts, since these forecasts will obviously be of little use if the absolute level of travel being predicted (and/or the spatial distribution of this travel) is seriously in error. Further, an understanding of the basic factors affecting trip generation rates is essential to formulating transportation policies that will meet the current and future travel needs of urban areas.

The availability of the TTS database provides an opportunity for researchers and planners to re-examine trip generation rates and relationships within the GTA. In particular, several

questions or issues exist which can be addressed, at least in a preliminary way, through analysis of this database. These issues, which were the focus of the Volume II work, include:

1. what is the most useful/appropriate "unit of analysis" for trip generation modelling (e.g., the person, the household or the zone)?

2. to what extent do trip generation rates depend upon characteristics of the individual traveller (e.g., age and gender) and/or of the traveller's household (e.g., auto ownership)?

3. to what extent do trip generation rates vary spatially (in particular, as one moves from dense, central areas through less dense suburban areas and on into sparse, rural areas within the GTA)?

4. can reliable methods for estimating non-work trip generations be developed that are comparable to work trip modelling methods?

Three general results that emerged from the work documented in Volume II. These are:

1. Relatively simple regresion models at either the household or the zone level can be used to represent home-based work and school trip making.

2. Non-work trip generation is far more difficult to model, given the complexity inherent in non-work travel behaviour. It can, however, perhaps be best represented at the level of the individual trip-maker as a function of the person's age, sex and residential location.

3. A simple "trip-end density" measure provides a useful means of classifying spatial locations as a basis for trip generation analysis.

More specifically, with respect to work trip generation, consider variability in work trip generation rates exists at the level of the individual trip-maker. Factors influencing this variability include the age and sex of the individual, the modal choices available to the individual, and the individual's residential location (characterized within this study in terms of the "urban density" of the individual's zone of residence). With the exception of the modal choice characteristics, however, the majority of this variability is due to variability in labour force participation rates by age, sex and location, since once the population has been mapped into full-time and part-time workers, very reliable relationships exist between home-end work trip rates and the number of full- and part-time workers, at either the household or the zone level (with, optionally a further disaggregation by gender). Similarly, work-end trip rates can be reliably estimated as a simple function of zonal employment.

Further, changes over time may be more likely to occur with respect to labour force participation rates (e.g., as younger, workplace-oriented women age) and/or full-time/part-time splits within the labour market (e.g., if the trend towards part-time employment, job-sharing, etc. continues) than with respect to worker trip rates per se. Finally, modal choice effects inherently depend on both the trip origin and destination (since it is the combination of these two which determine the modes available for the trip and the modal levels of service offered). Thus, modal choice effects presumably are best handled at a "post-distribution" phase of the analysis, rather than within the trip generation phase per se.

For all of these reasons, it appears that a sensible approach to work trip generation modelling involves the following general steps:

1. Predict the number of full-time and part-time workers by sex on a (small) zone basis as a function of the age-sex profile of the resident population and the labour force participation rate distribution expressed as a function of age and sex.

2. Predict the number of 24-hour home-to-work trips produced in each residential zone as a function of the number of full-time and part-time workers (disaggregated by sex, if desired) in the zone, estimated in step 1.

3. Predict the number of 24-hour home-to-work trips attracted to each employment zone as a function of the number of jobs located in the zone.

4. Factor work trips by mode and peak/off-peak periods of travel in subsequent stages of the analysis, preferrably after the trip distribution stage.

This recommended approach has the advantage of being sensitive to demographic changes over time, while maintaining a simple, reliable set of trip generation relationships. The major difficulty of the approach, of course, involves generating future age-sex profiles by zone and future labour force participation rate distributions by age and sex. It is suggested that these distributions may be computed by urban density class in a relatively straightforward and (hopefully) reliable way from available data. This suggestion is pursued in detail in this volume (i.e., Volume III), in which an operational model of work trip generation based on these concepts is developed and applied to the GTA.

As with work trips, considerable variability exists at the personal level in non-work trip rates as a function of age, sex, modal availability, and spatial location (urban density). Unlike work trips,

however, this variability is not successfully "aggregated away" by moving to the household or the zonal level. In particular, household-level regression models manage to explain only 2 to 4 percent of the total variability in household weekday shopping trip generation -- a totally unacceptable result. The one exception to this result is the school trip purpose, for which reliable trip generation relationships at either the household or the personal level are achieved. This is not surprising, given the regular, "work-like" nature of school travel.

For many planning purposes, non-work travel is of relatively minor importance, and hence this component of travel demand is often modelled in a very simple fashion, or else is simply ignored altogether. If, however, one is interested in assessing the overall magnitude of travel within an urban area, then non-work travel certainly cannot be ignored. Given the complexity of non-work travel behaviour, however, and the relatively poor operational models of this behaviour currently available, a suggested approach for modelling non-work travel consists of the following steps:

1. Split non-work travel into three components: home-based school trips, home-based "other" (i.e., non-work and non-school) trips, and work-based "other". This latter category is of importance, since a significant proportion of travel to non-work locations is, in fact, work-based rather than home-based in nature.

2. Generate the home-based trips for school and "other" purposes <u>by mode</u> on a per person basis as a function of the person's age, sex and residential zone density class. This, in turn, requires the generation of zonal population age-sex profiles in the same manner as required for the work trip generation analysis.

3. Generate work-based trips as a function of the total employment in the work zone.

4. If necessary, estimate non-home-based trips as a function of the population and employment located in the given zone.

The combination of modal choice within the trip generation phase (in contradiction of the case just made for avoiding such an approach in the work trip case) is justified partially on the grounds of simplicity but also partially on the grounds that transit usage for non-work travel tends to be more dependent on socio-economic factors and less on level of service considerations (i.e., a higher proportion of non-work transit users tend to be captive to the system) and hence is more readily combined within the trip generation phase of the analysis. It must be recognized, however, that this approach tends to "build in" existing modal split characteristics into forecasts of future travel behaviour to a far greater degree, both conceptually and in practical terms, than the work

trip assumption of a separate, post-distribution modal split component.

This suggested approach does, however, provide a mechanism for estimating future home-based and work-based non-work travel with essentially the same inputs as required for the work trip analysis and in a way which is sensitive to demographic and urban structure changes over time.

CHAPTER 3

A SCENARIO-BASED METHOD FOR INVESTIGATING FUTURE TRAVEL TRENDS AND THEIR POLICY IMPLICATIONS

3.1 Introduction

In order to explore some of the implications of the travel patterns observed in the 1986 TTS database for future transportation needs within the GTA, a relatively simple model of GTA travel demand was developed which permits estimates of future trip-making to be generated as a function of projected future demographic and spatial factors. In particular, the model permits the analyst to explore the possible impacts of a range of hypotheses or scenarios concerning future land use distributions and demographic changes on future levels of trip-making within the GTA, as well as on the spatial and modal distributions of this trip-making activity.

Section 3.2 describes the general modelling approach adopted and the major assumptions involved in implementing this approach. Section 3.3 then provides an overview of the actual model in terms of its constituent sub-models, the data inputs required, and the outputs generated. Further details concerning the model are provided in Appendices A through H at the back of this report.

3.2 Modelling Approach and Major Assumptions

Two major concerns or issues, both of which follow directly from the study objectives, guided the design of the model structure. These are:

1. a desire to focus the analysis on the overall level of trip-making within the GTA; and

2. an emphasis on the impacts of demographic and structural spatial changes on travel needs within the GTA.

The desired focus on overall trip-making levels translates in modelling terms into an emphasis on the trip generation component of the demand modelling process.[1] At the same time, however, it is clear that at least some information concerning the spatial, temporal and modal distributions of these trips is required if the full implications of projected trip-making levels are to

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[1] Which, in turn, accounts for the emphasis placed within the descriptive analysis component of the study on trip generation (i.e., all of the work documented in Volume II and much of the work presented in Volume I).

be assessed. Thus, the model must include trip distribution, modal split and peak/off-peak split components. As is made clear by the model overview presented in Section 3.3, the general strategy in developing these model components is to keep them as simple as possible. Often this is accomplished by simply using observed 1986 behaviour (e.g., observed 1986 work trip modal splits) as "the model" to project future behaviour.

The emphasis on overall levels of trip-making also implies a need to deal with all trips; that is, trips for non-work purposes as well as work trips. Given, however, both the importance of work trips within peak period travel (the time period of greatest interest for most planning issues) and the fact that our capability to model work travel in detail is far better established than for non-work travel, it seems appropriate to develop the work trip component of the model to a far greater extent than the non-work component. The results of this design decision are twofold. First, the work trip generation model is considerably more detailed than the non-work trip generation model. And second, the treatment of modal splits for non-work trips is handled even more simply than in the work trip case, while the trip distribution and peak/off-peak split components are ignored completely in the non-work case.

Inter-related with these model design decisions is the definition of what is meant within this model by the term "trip". In Volume II various definitions are employed, depending on the analysis used. In the model being presented here, the term "trip" might more properly be labelled as a "sojourn" or a "trip chain", in that it represents a journey that originates at home (or, in the case of non-work travel, trips can also originate at work), travels to one or more destinations and eventually returns to home (or work). Three trip purposes (as defined by the activity at the destination) are considered: work, school and "other". The origin for all work and school trips is the home (place of residence) of the worker or the student. The existence of intermediate stops for non-work or non-school purposes (e.g., shop, personal business, serve passenger) is ignored. The origin for other-purpose trips can be either the trip-maker's place of residence or place of work. Thus, other-purpose trips can be considered as being either "home-based" or "work-based" in nature.[2] The number of stops made during an other-purpose trip is not modelled, nor are the spatial locations of these stops.

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[2] Note that a work-based trip must involve the return to work as part of the sojourn. A trip from work to an other-purpose destination (e.g., shop) on the way home would not be a work-based other trip but rather part of the "home-based" work trip chain.

This definition of what is meant by a "trip" results in a less than full representation of literally all trip-making (in the sense of journeys between single origins and single destinations for a single purpose -- the traditional definition of a trip), since "return trips" and "intermediate trip links" are deleted from the analysis. Further, the definition makes it very difficult to talk meaningfully about "the destination" of other-purpose trips. The definition does, however, have several advantages, including:

1. It permits all trips to be readily associated with an origin point with well known properties (i.e, a place of residence or a place of employment).

2. It imposes minimal loss of information with respect to work trip-making, which is the prime focus of the model.

3. The restrictions it imposes on our representation of non-work travel are generally in keeping with our capabilities to model this travel component. In particular, our ability to model the spatial distribution of multi-stop, multi-purpose non-work travel is very limited. Thus, the adoption of a trip definition which precludes the need to construct such a model largely reflects analytical realities rather than being an arbitrary or unnecessary assumption.

4. The inclusion of work-based other-purpose trip chains captures an important component of other-purpose travel.

5. The definition does provide a consistent and comprehensive definition of trip-making in that all trip chains do, in fact, originate (and terminate) at home or at work.

The focus on demographic and spatial factors in determining trip-making partially derives from the project's terms of reference, in which these aspects of the travel demand problem are emphasized, and partially from a decision made early in the study that transportation network effects simply could not be addressed within the budget and time constraints of this project. This exclusion of transportation network effects from the analysis further reinforces the need for a relatively simplistic treatment of the trip distribution and modal split components of the problem, since changes over time in these two components of travel behaviour (particularly changes in modal split) can be expected to depend in a significant way on transportation network changes. The impact of transportation network changes on trip generation levels (the main focus of this study), however, is far less clear, and certainly conventional travel demand models assume virtually zero impact since they are generally expressed as functions solely of demographic and spatial factors.

As is documented in Volume II, both an analysis of 1986 GTA travel patterns and a review of the recent literature indicate the importance of demographic factors such as age and gender on

trip generation rates. In the case of work trips, these factors are fundamental in determining the labour force participation of the population. Once the labour force participation level is known, then work trip generations can be predicted with reasonable accuracy using simple linear regression models. The impact of demographic factors on non-work travel are more complex and less well understood. Given this, a practical modelling strategy appears to be to model non-work trip generation rates directly as a function of trip-makers' age and sex.

Two major assumptions are involved in this approach to trip generation modelling. The first is that age-sex distributions for the resident population in small areas (i.e., traffic zones) can be projected for future years. This issue is discussed further in Section 3.3, in which the procedure adopted for generating population age-sex distributions by zone is presented.

The second assumption is that labour force participation rates and non-work trip generation rates by age and sex are known for the forecast year. In this study it is assumed that observed 1986 distributions hold in the forecast years. It is, however, unlikely that either of these distributions will, in fact, remain fixed over time. It is, of course, possible to enter alternative age-sex distributions of labour force participation rates and/or non-work trip generation rates into the model, but this has not been attempted within this project.

The impact of spatial structure on trip generation rates is explored in some detail in Volume II. Emerging from this analysis is the concept of "urban density" as a useful composite measure of spatial structure and a useful variable in explaining travel behaviour. In particular, Volume II illustrates the usefulness of classifying residential zones by "density class" prior to computing non-work trip generation rates as a function of trip-maker age and sex. In addition, labour force partipation rates by age and sex tend to vary systematically across density classes, as do work trip modal splits.[3] Thus, urban density appears to provide a simple but effective means of linking both work and non-work trip-making activity with spatial structure. In particular, it is reasonable to assume that as a zone's density (i.e., level of urbanization) changes over time, that the trip-making propensity of the zone will change as well.

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[3] This latter result is particularly useful given the lack of modal network level of service characteristics in the model. That is, it is reasonable to assume that transit service levels in particular are apt to vary systematically with density level. Thus, density class may well serve as a useful proxy for the relative modal levels of service provided within a given residence zone.

This linkage of travel behaviour and zonal density assumes that future density levels can be projected for each zone in the study area. As developed in Volume II, "urban density" is originally defined in terms of the total number of 1986 trip ends observed in a given TARMS zone divided by the zone's area. While useful for the descriptive analysis presented in Volume II, such a definition is clearly inadequate for projecting future trip generation levels by zone. As discussed in more detail in Section 3.3, however, since total zonal trip generation tends to be highly correlated with zonal population and employment levels, it is possible to redefine the concept of urban density (which, in practical terms means redefining the means by which zones are assigned to a particular density class) as a function of zonal population and employment totals. This, in turn, enables future density classes to be assigned to each zone in the system as long as zonal population and employment projections are available for the forecast year.

Several zone systems are used within the model. The base zone system is the 1979 TARMS zone system. All trip generation calculations are performed at this level. This means, in turn, that population and employment forecasts at the TARMS zone level are required inputs into the model, and that future population age-sex distributions and density classifications must be generated within the model at the TARMS zone level. This very fine level of disaggregation is employed primarily because of the model's dependency on the density class variable, which clearly is only meaningful for relatively small, relatively homogeneous zones. It also, however, maintains flexibility within the model in terms of being able to support subsequent aggregation of results to virtually any zonal representation desired.

The work trip distribution and mode split modelling components work at the 46 zone level (i.e., planning districts and local municipalities). This more aggregate level of analysis reflects the simple models used in these modelling stages. At the same time, it provides a sufficient level of spatial detail for the purposes of this study.

Finally, most of the standard outputs of the model are summarized at the level of the six regional municipalities which comprise the GTA. This high level of aggregation is employed to minimize the volume of output generated by the model and to facilitate the analysis of the model's projections. This "broad brush" representation of projected travel within the GTA is undoubtedly the most reliable level at which the results generated by what is really a very simple model of travel demand can be viewed. It is also perhaps the most useful level for the purposes of this study, since

it provides a "strategic overview" of overall trip-making levels and flows, categorized by the major political entities involved in transportation planning: the regional municipalities. Given the more disaggregate nature of most of the numbers being generated internally within the model, however, more spatially or demographically detailed outputs can be readily generated, as required.

Figure 3.1 summarizes the overall conceptual structure of the model. The major inputs into the model include forecast year population and employment totals by TARMS zone, forecast year age-sex distributions for the resident population, labour force participation rates by worker age and sex, and observed 1986 travel behaviour (observed work trip mode splits, etc.). The model consists of many components, but for ease of discussion it can be broken into three major logical units: a work trip generation component; a component which deals with the other dimensions of work travel demand (distribution, modal split, and temporal split); and a component which deals with non-work travel demand. The outputs of the model, as discussed above, then consist of various summaries of trips and flows by purpose, mode, regional municipality, etc.

The model is called a scenario-based model because it depends upon the judgemental specification of a future scenario to provide the inputs required for its execution. Thus, in principal, any one or more of the fundamental inputs into the model (population and employment distributions, labour force participation rates, etc.) can be judgementally altered (presumably in a "reasonable" way) in order to use the model to explore a range of "what if" questions. Note, of course, that maintaining a given input at its "base" value (e.g., assuming 1986 work trip modal splits hold in the future) is as much an assumption as the decision to alter the value. Chapter 4 discusses the scenario specifications examined in this study as well as presents the results generated by the model for these scenarios.

3.3 Model Overview

This section describes in more detail the model introduced in Section 3.2. It is divided into five sub-sections. The first three deal with the three major demand model components identified in Figure 3.1: work trip generation; work trip distribution and modal split; and non-work travel. The final two sub-sections deal with two important demand model "support" components required to convert the data inputs provided to the model into the form required by the demand model <u>per se</u>: the density class model, which predicts future TARMS zone density classes; and the demographic model, which predicts future TARMS zone population age-sex distributions.

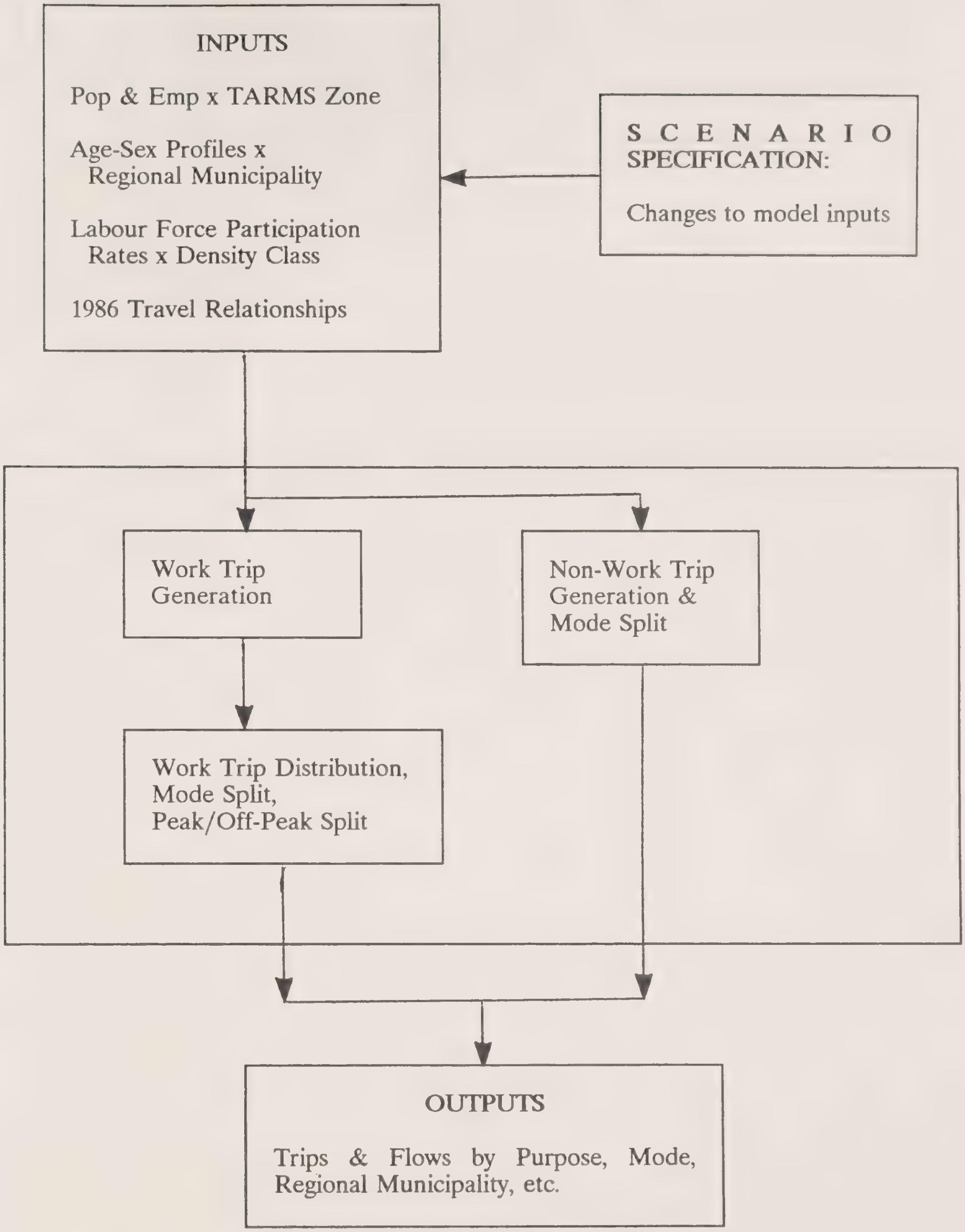

Figure 3.1

Overall Model Structure

3.3.1 Work Trip Generation

Figure 3.2 presents a flowchart of the models and information flow involved in computing work trip generation levels by zone. These work trips are 24-hour trips. Morning peak period and off-peak trips are computed from these total 24-hour trips in a subsequent section of the model (see Section 3.3.2).

The fundamental inputs into this model component are the total population and employment for each TARMS zone for the forecast year. Given this, the density class model predicts the forecast year density class for each zone (see Section 3.3.4). Given each zone's projected density class, total population and regional municipality, the demographic model then estimates the age-sex distribution for each zone's resident population (see Section 3.3.5). Once these zonal age-sex distributions are known, 1986 labour force participation rates by density class, age and sex (as observed in the TTS database) are used to generate the number of full- and part-time workers, by sex, for each TARMS zone. Appendix A contains the age-sex distributions of full-time and part-time labour force participation rates for each of the six density classes.

The actual trip generation model consists of three linear regression equations which predict the total number of male work trip "productions" for each residence zone, the total number of female work trip "productions" for each residence zone, and the total number of work trip "attractions" (male and female combined) for each employment zone. First presented and discussed in Volume II, these equations are reproduced in Table 3.1. Note that the simpler employment zone trip attraction equation, which is not disaggregated by either worker gender or employment status, must be used since it is beyond current capabilities to project future small zone employment levels by gender or employment status with any reliability. This simplification results in the slightly lower (but still very acceptable) R^2 value for the trip attraction equation, as well as introduces some additional complexity into the trip distribution model used (see Section 3.3.2 and Appendix B).

The final step in the work trip generation process involves "balancing" the predicted zonal trip generations and atttractions so that they sum to the same total number of trips. In this case zonal trip productions were proportionately factored up or down, as required, so that their total equals the predicted total number of trip attractions. This approach was adopted, since it was felt that the projected zonal employment totals are likely to be more reliable than the zonal population totals, and, hence, that the aggregate trip attraction estimates would likely be more reliable than the corresponding trip productions.

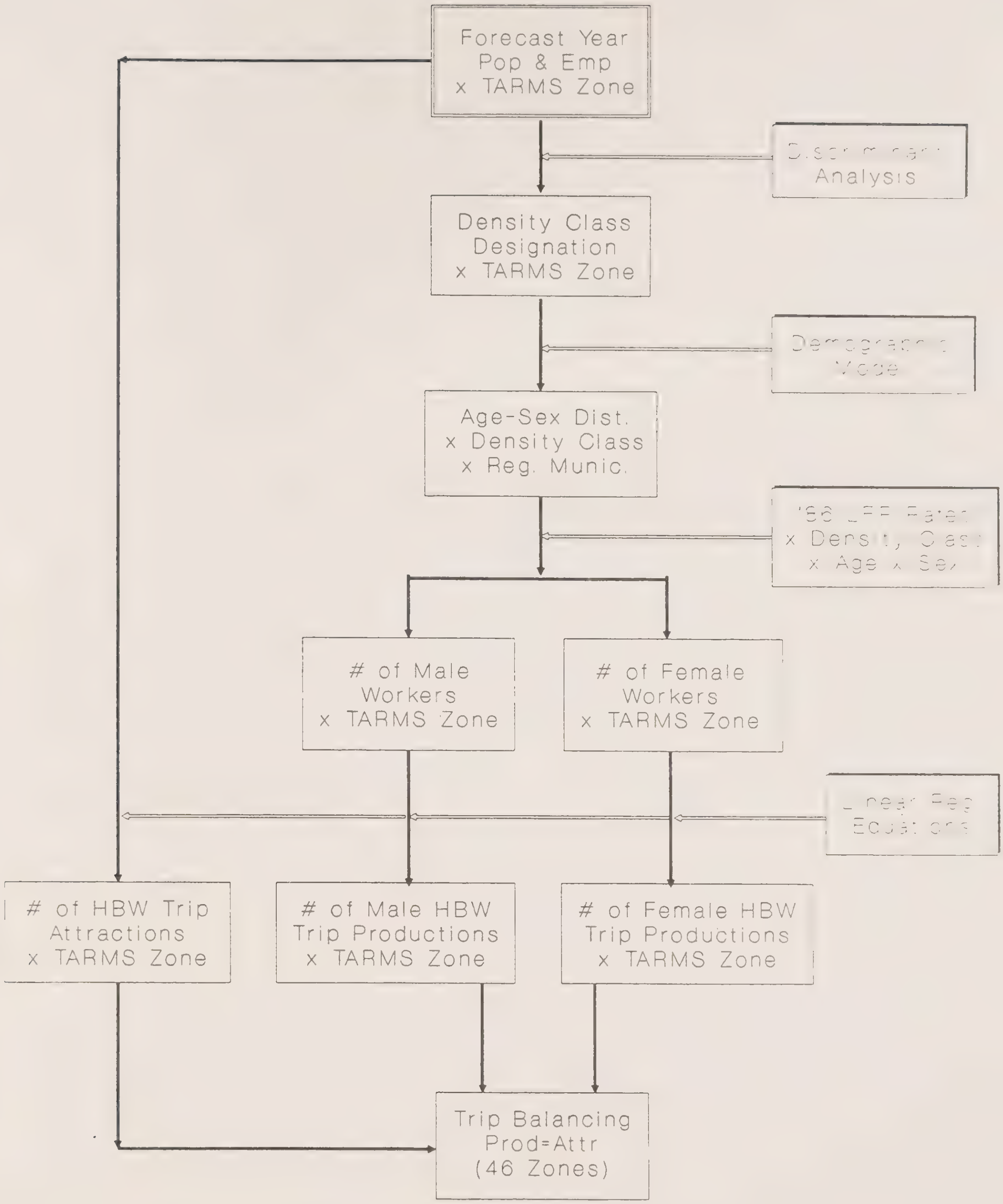

Figure 3.2

The Work Trip Generation Model

Table 3.1

Work Trip Regression Equations

[3.1] $TRIPS_{male} = -4.103 + 0.779*FTW_{male} + 0.345*PTW_{male}$ ($R^2 = 0.988$)

[3.2] $TRIPS_{fem} = -6.126 + 0.801*FTW_{fem} + 0.387*PTW_{fem}$ ($R^2 = 0.987$)

$TRIPS_i$ = No. of 24-hour home-based work trip chains "produced" in home-zone, for sex i

FTW_i = No. of full-time workers, sex i, in home zone

PTW_i = No. of part-time workers, sex i, in home zone

[3.3] $TRIPS_{wb} = 6.117 + 0.0391*EMP$ ($R^2 = 0.785$)

$TRIPS_{wb}$ = No. of 24-hour "other purpose", work-based trip chains generated in the work zone

EMP = No. of jobs in the work zone

All coefficients for the explanatory variables are statistically significant at a 95% confidence level or better, as are the intercept terms for equations [3.1] and [3.3]. The intercept term for equation [3.2] is not significantly different from zero at standard levels of confidence.

3.3.2 Work Trip Distribution, Modal Split and Temporal Split

Figure 3.3 presents the flowchart of the major tasks and information flow involved in the remaining components of the work trip demand forecasting process.

The main inputs into this section of the model are 24-hour work trip productions by worker gender, aggregated to the 46 zone system, and total 24-hour work trip attractions, also aggregated to the 46 zone system. An "entropy" trip distribution model is used to estimate forecast-year O-D flows for the 46 zone system for male and female workers. Appendix B provides the methodological details of the model used. The key point to observe concerning this model is that it generates "least biased" or "most likely" estimates of the future O-D matrix, given the known information about the future system (i.e, the future zonal trip productions and attractions), as well as the known base year (1986) O-D flows. It can be perhaps be best thought of as a generalization of the "Fratar" proportional updating methods which are often used within the GTA for projecting future trip distributions.

Observed 1986 morning peak/off-peak splits in work trip start times, calculated on a regional muncipality to regional municipality basis, by sex, are then used to split the male and female O-D work trip matrices into peak and off-peak matrices (see Table 3.2). The use of O-D based peak period factors is motivated by the fact that trip start times will generally depend upon both the origin and destination locations, as well as the distance between these locations. The use of the very aggregate regional municipality as the zone system in this case is based on the judgement that this provides a sufficient level of detail for current purposes, and on the observation that peak period splits based on a 46 zone O-D basis are unlikely to be overly reliable.

Observed 1986 modal splits are then used to split the O-D flows into trips by auto (drive and passenger), transit (TTC, GO, etc.) and walk (plus "other" modes such as bicycle). These mode splits are calculated on an origin-destination basis using a special 13 "zone" system defined in terms of a cross-classification by regional municipality and density class (see Table 3.3). In other words, 1986 modal splits tabulated by mode, sex, time period, regional municipality and density class are used to split the four O-D tables (male/female by peak/off-peak) into 12 O-D tables (auto/transit/walk by male/female by peak/off-peak). Appendix C contains the tabulations of the TTS modal splits used in this analysis.

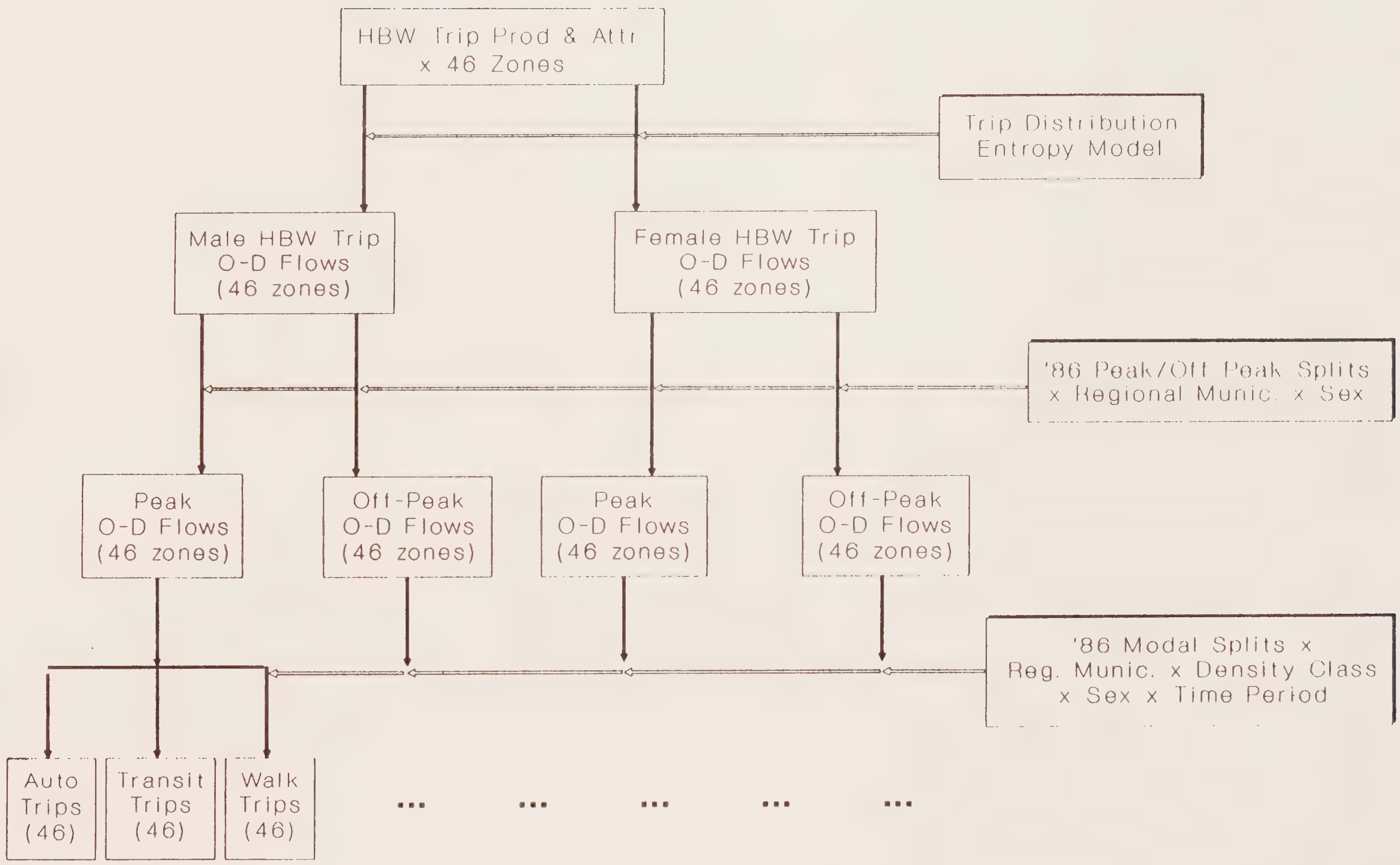

Figure 3.3

Work Trip Distribution, Mode Split and Peak/Off-Peak Split Models

Table 3.2

1986 Work Trip Peak/Off-Peak Start Time Splits

A. Fraction of Trips During Peak Period, Male Workers

Origin	Destination: Metro	Durham	York	Peel	Halton	Hamilton-Wentworth
Metro	0.747	0.794	0.794	0.794	0.667	0.667
Durham	0.812	0.761	0.761	0.761	0.754	0.760
York	0.812	0.761	0.761	0.761	0.754	0.760
Peel	0.812	0.761	0.761	0.761	0.754	0.760
Halton	0.855	0.832	0.832	0.832	0.732	0.798
Hamilton-Wentworth	0.61	0.691	0.691	0.691	0.770	0.740

B. Fraction of Trips During Peak Period, Female Workers

Origin	Destination: Metro	Durham	York	Peel	Halton	Hamilton-Wentworth
Metro	0.785	0.804	0.804	0.804	0.815	0.685
Durham	0.845	0.722	0.722	0.722	0.707	0.764
York	0.845	0.722	0.722	0.722	0.707	0.764
Peel	0.845	0.722	0.722	0.722	0.707	0.764
Halton	0.882	0.819	0.819	0.819	0.668	0.866
Hamilton-Wentworth	0.782	0.792	0.792	0.792	0.763	0.702

Table 3.3

Work Trip Mode Split Analysis "Zones"

Mode Split Analysis Zone	Regional Municipality	Density Class
1	Metro Toronto	6
2	Metro Toronto	5
3	Metro Toronto	4
4	Metro Toronto	3,2,1
5	Durham	6,5,4,3
6	Durham	2,1
7	York	6,5,4,3
8	York	2,1
9	Peel	6,5,4,3
10	Peel	2,1
11	Halton	6,5,4,3
12	Halton	2,1
13	Hamilton-Wentworth	6,5,4,3,2,1

Since any given zone within the 46 zone system will generally contain TARMS zones from more than one density class, a procedure is required to estimate the composite modal splits for an O-D pair based on the 46 zone system (the basis for the O-D flow matrices being developed) from the observed O-D modal splits expressed with respect to the 13 zone system of Table 3.3 and Appendix C. Appendix D documents this procedure, which is based on a straightforward weighted averaging of the modal splits for the elements of the 13x13 mode split matrix which are included within a given cell of the 46x46 O-D matrix.

3.3.3 Non-Work Trip-Making

As shown in Figure 3.4, the inputs to the non-work trip generation component are exactly the same as for the work trip generation component: forecast year population and employment totals by TARMS zone, which are then used to generate forecast year TARMS zone density classes and population age-sex distributions. This information is used to directly estimate the future number of 24-hour, non-work, "home-based" trips generated in each TARMS zone, disaggregated by purpose (school, "other") and mode (auto, transit), using observed 1986 trip rates categorized by mode, purpose, density class, age and sex (see Appendix E).

Work-based "other" purpose trips, on the other hand, are estimated using the following linear regression equation, first presented in Volume II:

[3.4] $TRIPS_a = -10.334 + 0.715*EMP$ ($R^2 = 0.878$)

where: $TRIPS_a$ = No. of 24-hour home-based work trip chains "attracted" by the work zone

EMP = No. of jobs in the work zone

These total work-based trips are then split into auto and transit trips using the observed 1986 average modal splits for the work zone's regional municipality.

It is clear from both the original TTS survey validation exercise [MTO, 1988a] and more recent detailed comparisons of the TTS data with the Travel Diary Survey (TDS)[4] that non-work

4 The Travel Diary Survey was executed as a follow-up to the TTS. It involved having a 10% sub-sample of the original TTS sample complete a more detailed one-day travel diary. See Tranplan [1990] for a detailed discussion of the TDS survey and its validation.

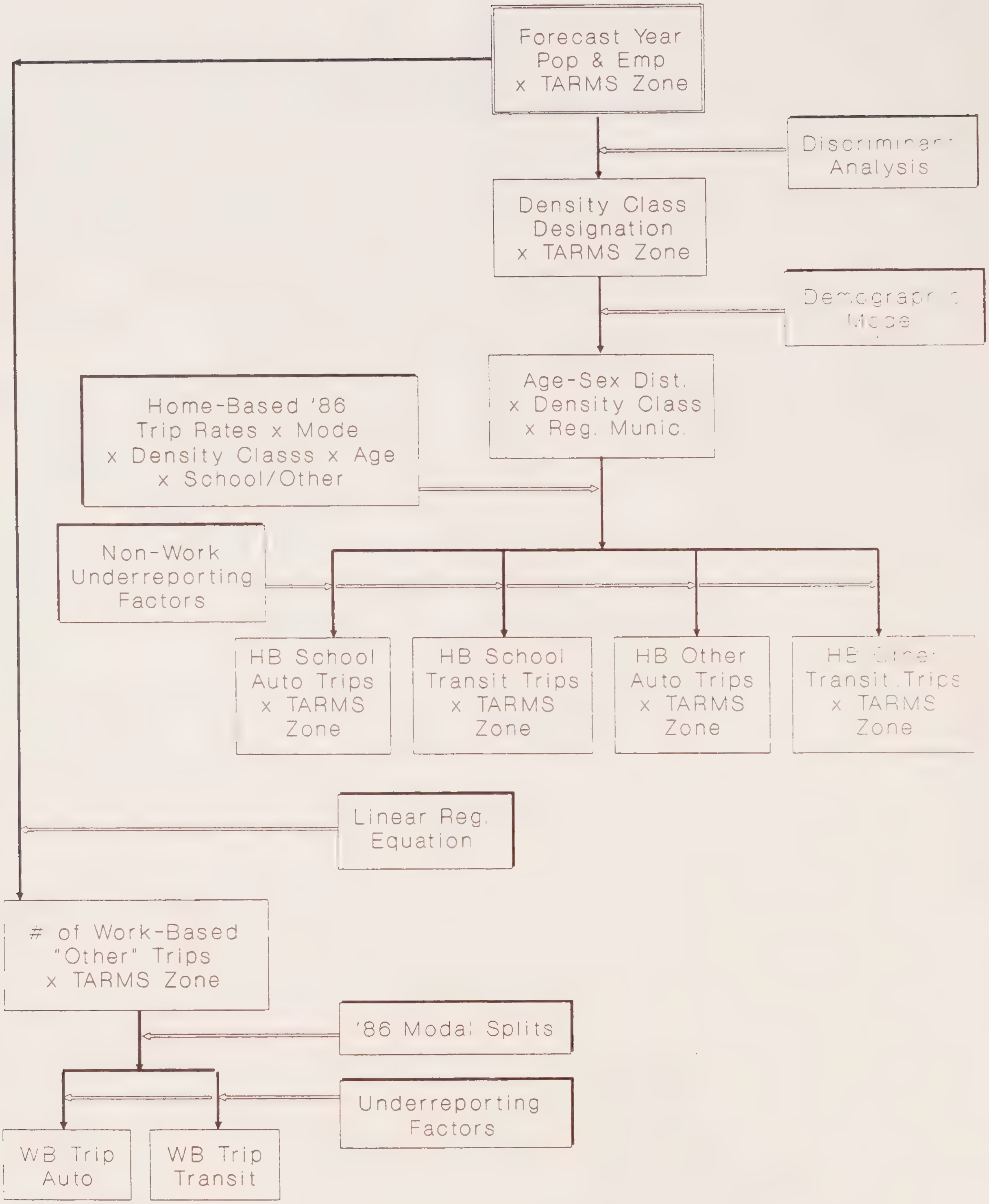

Figure 3.4

The Non-Work Travel Demand Model

trips are significantly under-reported in the TTS. Thus, the under-reporting factors shown in Table 3.4 are used to factor up the trip generation rates calculated from TTS-based data contained in Appendix E.

3.3.4 Density Class Model

Given the central role which the density class of each TARMS zone plays in the computation of trip generation and modal splits within this model, the ability to predict future zonal trip densities with reasonable accuracy is fundamental to the overall performance of the model as a predictive tool. This is particularly the case given that one would expect the density class of many zones to change over time as the urbanization process continues throughout the GTA. As noted in Section 3.2, the original definition of zonal density as the total number of observed trip ends (productions plus attractions) generated in a zone, divided by the zone's area is hardly suitable to estimate future zonal density classes which are then the fundamental inputs into models designed to predict trip generation levels!

Since it is clear that zonal trip generation levels tend to be highly correlated with zonal population and employment levels, attempts were made to develop regression equations in which zonal trip density was expressed as a function of zonal population and employment densities. Both linear and non-linear functional forms were examined, with little success: typically 20% or fewer zones could be placed in their correct 1986 density class by such models.

Given these discouraging results, a discriminant analysis model was then investigated. Discriminant analysis consists of a variety of methods designed to assign each of a set of observations (e.g., zones in this case) to exactly one group or category within a set of discrete groups (e.g., assign each zone to a density class), based on the attributes of the observation (e.g., the zone's population and employment densities). A discriminant model is calibrated by finding the model which performs best in assigning a set of observations to their known groups. This model is then used to assign new observations (i.e., zones in future forecast years) to groups based on the values of their characteristics.

Appendix F contains further details of the discriminant model developed. This model is able to classify 76% of the TARMS zones to their correct 1986 density class, while it classifies 99% of the zones to within plus or minus one level of their correct density class. Figure 3.5 also plots the 1986 zonal work trip productions predicted by the model (which represents a combination of

Table 3.4

Non-Work Trip Under-Reporting Adjustment Factors

Trip Purpose	Mode	Adjustment Factor
HB School	Auto	1.31
HB School	Transit	0.88
HB Other	Auto	1.09
HB Other	Transit	1.08
WB Other	All	1.85

the density class model and the actual work trip generation models discussed in Section 3.3.1) versus the observed values. As indicated by this figure, the model is, in fact, able to fit the observed data well (the R^2 for the scatterplot is 0.93) and hence should provide a credible tool for projecting future work trip generation levels.

3.3.5 Demographic Model

The trip generation modelling approach adopted in this study requires age-sex distributions for the resident population of each TARMS zone. Demographic data for forecast years available to this study consisted of MTO projections of TARMS zone total population levels and Ministry of Treasury and Economics projections of age-sex distributions by regional municipality.[MTE, 1989] In addition, 1986 age-sex distributions by density class were available from the TTS dataset.[5]

The modelling approach adopted is to estimate the forecast year age-sex distribution by regional municipality by density class, given the three major inputs shown in Figure 3.6: forecast year total population by regional municipality and density class (obtained by simply summing the populations of the TARMS zones belonging to each regional municipality - density class combination); the forecast year age-sex distribution by regional municipality; and the observed 1986 base year age-sex distribution by density class. This estimation process is exactly analagous to the classic trip distribution modelling problem, in that a more detailed matrix of information (i.e, the O-D trip matrix, or the age-sex distribution by regional municipality by density class) must be estimated from more limited information (i.e., zonal productions and attractions, or the "marginal" age-sex distributions by regional municipality and (separately) by density class), in a logicaly consistent, analytically "least-biased" way. Thus, just as in the trip distribution case discussed in Section 3.3.2, an entropy model is used to accomplish this task of synthesizing the desired estimates from the known inputs. The details of this model are presented in Appendix G, while the resulting distributions by regional municipality by density class are tabulated in Appendix H.

Once the forecast year age-sex distribution for each regional municipality - density class combination is known, then this distribution is assumed to hold for each TARMS zone contained within the municipality - density class combination.

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[5] Age-sex distributions by regional municipality are, of course, also available from the TTS dataset. Ideally, one would want to construct these distributions by density class and regional municipality. This, however, leads to very small numbers of observations within most cells and hence to a very low level of reliability.

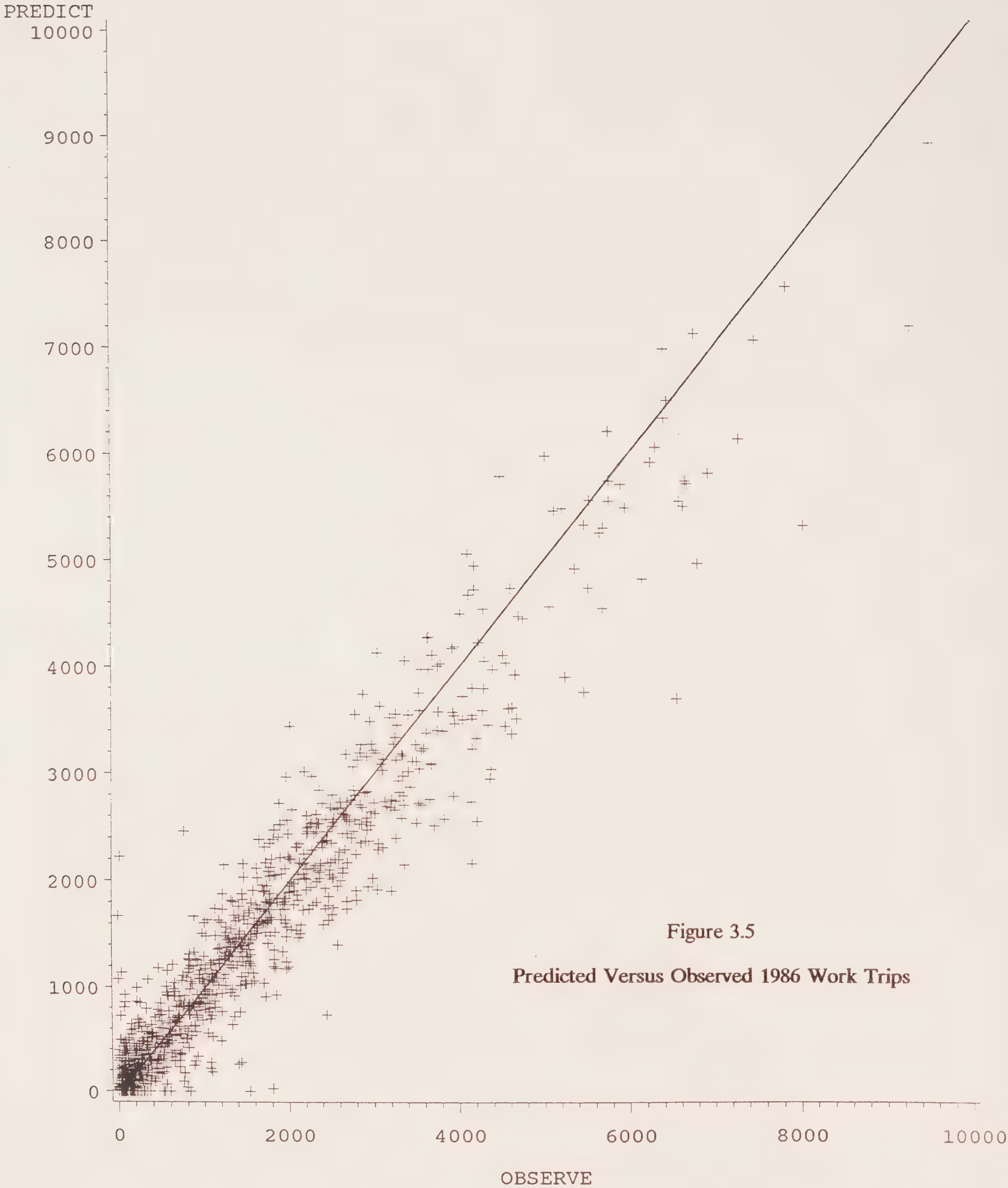

Figure 3.5

Predicted Versus Observed 1986 Work Trips

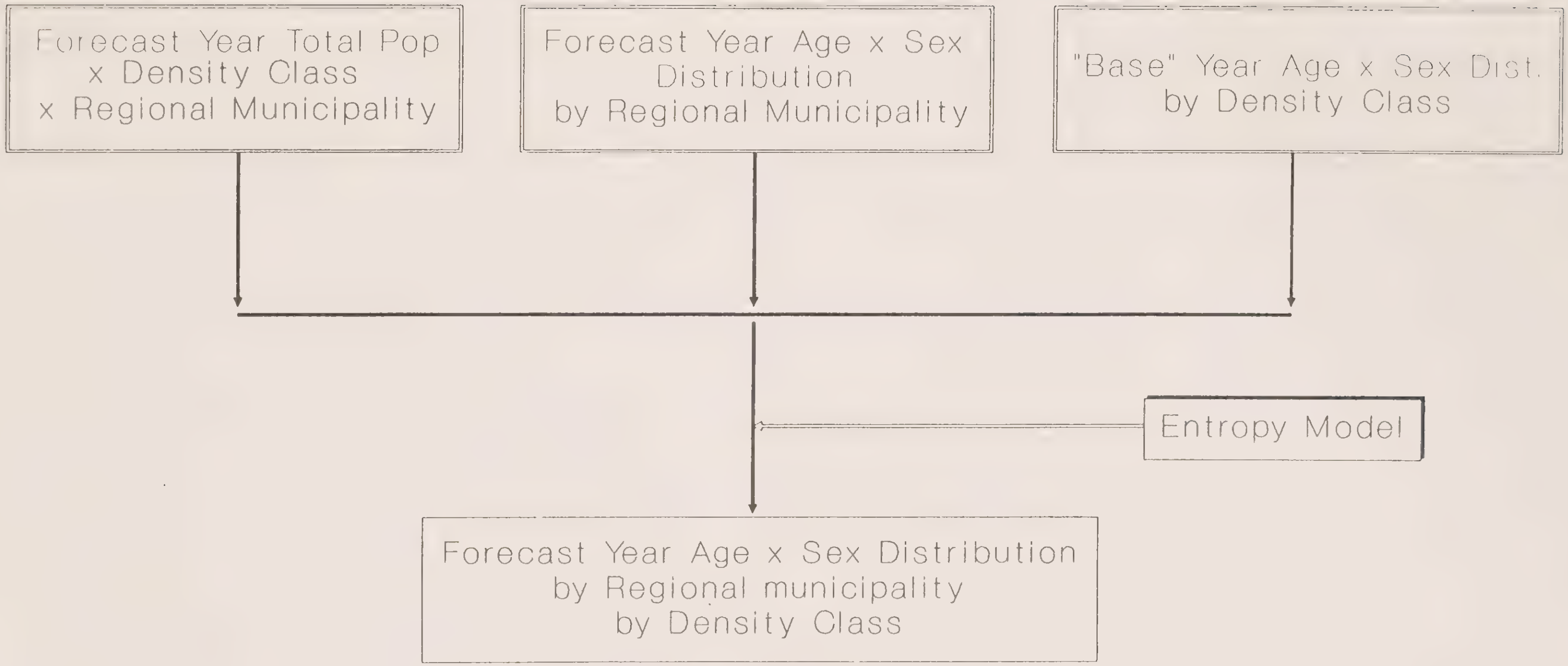

Figure 3.6

The Demographic Model

CHAPTER 4

ANALYSIS OF SCENARIOS

4.1 Introduction

This chapter discusses the application of the model presented in Chapter 3 in the analysis of four land use scenarios. Section 4.2 describes the four scenarios examined, while Section 4.3 presents and discusses the modelling results obtained for each of these scenarios.

4.2 Definition of Scenarios

The base scenario for this study ("Scenario 0") is defined by the following inputs:

1. current MTO population and employment projections for the forecast year by TARMS zone;

2. current projections of MTE age-sex distributions for the forecast year by regional municipality (MTE, 1989);

3. 1986 labour force participation rates by age and sex, by zonal density class; and

4. 1986 TTS travel relationships (trip generation rates, mode splits, etc., as discussed in Chapter 3).

While in principle any one or more of these basic inputs can be altered within a given scenario, in this study it was decided to limit the scenarios examined to changes in the basic "land use" inputs of zonal population and employment totals. Two considerations underlay this decision. The first is that an examination of alternative population and employment distributions directly addresses the question of "urban structure" and its impact on travel needs, which is one of the motivating concerns of the study. The second is that modification of one or more of the other principal inputs (labour force participation rates, modal splits, etc.) is much more difficult to do in a consistent, useful way, especially given the relatively limited time available within this study for this component of the work.

Three alternative population and employment distributions were tested in addition to the base case. Each one is a "generic" alternative to the base forecast designed to represent a substantially different evolutionary urban form relative to the base forecast. The scenarios tested are admittedly abstract and overly simplistic in their formulation, largely reflecting the limited

resources available for their construction. They also have been deliberately specified to represent extreme cases (i.e., more or less the maximum shifts from the base trend that might be reasonably imagined). Despite these caveats, however, the scenarios are not totally unrealistic in nature and are believed to be useful in delineating the nature of the differences in travel needs that are likely to arise if alternative urban structures are actively promoted. Finally, it should be noted that these scenarios were constructed independently of the on-going work of the Office of the Greater Toronto Area (OGTA) and their consultants, who are involved in constructing alternative scenarios for the GTA. The OGTA scenarios simply were not in a useable state at the time that this work was undertaken and so could not be used. It is hoped, however, that some of the scenarios considered in this study are at least somewhat consistent with the scenarios being developed by the OGTA.

In all three cases the alternative scenarios were constructed keeping the total GTA population and employment totals constant, so as to facilitate inter-scenario comparisons. The three scenarios are defined below.

Scenario 1, "Centralization": The objective of this scenario is to explore the impact of increased development within Metro combined with decreased growth in the other GTA regions. This scenario was constructed as follows:

1. 15% of the projected growth (relative to the 1986 base) in both population and employment in each non-Metro TARMS zone was subtracted from the zone's forecast year population and employment.

2. The total population and total employment subtracted from the non-Metro zones were added to Metro zonal population and employment totals. Each Metro zone was allocated a proportion of this population or employment increment which was equal to the proportion of projected base Metro growth found in the given zone. Thus, if zone x had 5% of the total Metro population growth in the base forecast, it would receive 5% of the reallocated population in this scenario. In other words, zones which are projected to receive relatively large amounts of growth in the base scenario receive even larger amounts of growth in this scenario, while stable zones in the base scenario remain stable in this scenario. Metro zones projected to have negative growth in the base scenario are excluded from these adjustments and so continue to have negative growth in this scenario.

Scenario 2, "Densification": Scenario 1 attempts to represent one approach to increased concentration of trip-generating activites, that of focussing these activities within the GTA "core" of Metro Toronto. An alternative approach is to try to concentrate activities <u>within</u> each of the GTA's regional municipalities. To simulate this type of development, the following calculations

were performed:

1. 50% of the base case projected population and employment growth in each "low density" (density classes 1 and 2) TARMS zone in each regional municipality was subtracted from the zone's totals.

2. The total population and employment subtracted from the low density zones were reallocated within the same regional municipality to "high density" (density classes 3 through 6) TARMS zones. This reallocation was based on the same proportional-to-base-growth procedure used for the Metro zones in Scenario 1. Thus, activities within each regional municipality are concentrated within the traditionally denser, more highly developed portions of the municipality, thereby reducing the amount of "sprawl" occuring within each municipality.

Scenario 3, "Self-Containment": Given that in the base case much of the population growth is projected to occur in the regions outside of Metro, while much of the employment growth is still projected to occur within Metro, an alternative urban structure of interest is one in which a better match between population and employment (and, hence perhaps less need for long work trips) is achieved within each region of the GTA. In this scenario, improved "self-containment" is achieved through the following steps:

1. 50% of the base case projected employment growth in Metro zones was subtracted from these zones' employment totals.

2. The employment growth which was removed from Metro was allocated to the other regional municipalities in proportion to their share of the non-Metro population growth (i.e., if a given region in the base case is projected to receive y% of the non-Metro population growth, then y% of the shifted employment was allocated to this regional municipality). Thus, regions experiencing relatively high population (resident labour force) growth rates receive a relatively high proportion of the reallocated employment.

3. The employment allocated to a given regional municipality was then allocated to TARMS zones within the region in the usual way (i.e., proportional to the base case fraction of regional employment growth projected for the zone).

In all four scenarios (base plus three alternatives), projections were generated for the year 2001 and the year 2011. These projections were then compared with the 1986 base case as defined by the TTS database.

4.3 Discussion of Results

Appendix I contains a set of summary output tables for each of the four scenarios

considered for both the 2001 and 2011 forecast years, as well as comparable data from the 1986 base year. In the following subsections the results for each scenario are discussed in turn.

4.3.1 Scenario 0: "Base Case"

Table 4.1 presents the total number of 24-hour weekday trips[1] for all purposes originating within each of the six regional municipalities for 1986 (TTS) and for 2001 and 2011 (projected).[2] The absolute and percentage changes in these trips over time (relative to the 1986 base), and the aggregate modal splits (expressed as the percentage of trips using the auto mode) for these trips are also shown. Points to note from this table include:

1. Considerable growth in total trip making is projected for the period 1986-2001 in all regions except Hamilton-Wentworth, which is projected to have a relatively modest growth of approximately 64,000 trips. In percentage terms, York Region is expected to experience the greatest increase (98%), while Peel is expected to have the largest absolute increase in trip generations (343,000). The increase in trips generated within Metro, while small in percentage terms (13%), is still significant in absolute terms (230,000).

2. In general, the projected growth during the period 2001-2011 is less than during the pre-2001 period, but is still numerically significant, especially in Peel and York Regions. By the year 2011, the total growth in York (relative to the 1986 base) is expected to have exceeded that of Peel (474,000 trips versus 446,000), although Peel Region will still remain the second largest generator of trips (941,000 trips) after Metro (2,005,000 trips).

3. The aggregate modal splits are projected to remain virtually constant, with at most a slight general increase in auto usage relative to transit.

While this last result may be partially a function of the use of 1986 modal splits to represent future travel behaviour (see Sections 3.3.2 and 3.3.3), it is still somewhat surprising given the fact that much of the population growth is projected to occur in the non-Metro regions which traditionally tend to be auto-oriented in nature. Further, it was expected that the general shift in population age-sex profiles might also encourage auto usage (i.e., more people would be moving into age categories that tend to favour the auto than would be moving into transit-oriented age groups). It would appear, however, that aggregate modal splits are the result of a more complex

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1 Recall from the discussion in Chapter 3 that these are actually home-based or work-based trip chains. The term "trip" is, however, consistently used for the sake of simplicity in the discussion.

2 These totals exclude walk trips since walk trips were not computed for non-work purposes.

Table 4.1

Total Trip Origins By Regional Municipality,
Base Scenario

Regional Municipality	Total Trips (Auto + Transit) (Thousands of Trips per Day) 1986	2001	2011	Mode Split (% Auto) 1986	2001	2011
Metro	1,747	1,977	2,005	70.3	72.8	72.6
Durham	276	486	572	90.1	89.1	88.9
York	304	603	776	86.7	89.1	89.1
Peel	495	838	941	87.4	87.9	87.6
Halton	254	362	446	91.1	90.2	90.0
Hamilton-Wentworth	353	417	421	86.2	86.6	86.9

Regional Municipality	Change in Trips, Relative to 1986 2001	2011	% Change in Trips 2001	2011
Metro	230	258	13	15
Durham	210	296	76	107
York	299	472	98	155
Peel	343	446	69	90
Halton	108	192	43	76
Hamilton-Wentworth	64	68	18	19

Regional Municipality	Change in Trips, Relative to 2001 2011	% Change in Trips 2011
Metro	28	1
Durham	86	18
York	173	29
Peel	103	12
Halton	84	23
Hamilton-Wentworth	4	1

set of interactions than this, which, in this case at least, tend to compensate for one another. Thus, for example, as the population ages there will be relatively fewer women in prime child-bearing years staying home with their children and generating a large number of auto "serve passenger" trips (an important portion of all non-work travel, see Volume II). Also, as the non-Metro regions grow they also tend to densify, which implies within the model that they will become more transit oriented in their travel behaviour.[3] Finally, increased work trip rates (see discussion of Table 4.3, below) may also help increase aggregate transit usage, since work trips are typically more transit oriented (regardless of trip origin) than non-work trips.[4]

Table 4.2 provides some additional detail on aggregate modal usage by breaking down the total trips originating in each region into auto trips and transit trips, for 1986 and 2001. Points to note from this table include:

1. There is virtually an order of magnitude difference between the increase in auto trips versus the increase in transit trips (1,123,000 versus 129,000). Thus, while the aggregate modal split may not be projected to change dramatically, the net impact on the road system is projected to be significantly larger than that which is projected to occur on the transit system.

2. Despite point 1, accomodating 129,000 additional round trips per day on the GTA-wide transit system may well require significant expansion of this system.

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3 Since the modal splits used in the model depend on the density class of both the origin and the destination zone of the trip. In general, these (transit) modal splits increase with increasing density class. Note that this model implicitly assumes that transit services improve in step with the densification process.

4 Note that this can hold true even if the work trip transit mode split declines somewhat.

Table 4.2

Auto and Transit Trip Origins by Regional Municipality, Base Scenario

Regional Municipality	Daily Auto Trips (Thousands of Trips) 1986	2001	Change in Trips 1986 to 2001
Metro	1,228	1,439	211
Durham	249	433	184
York	264	538	274
Peel	433	736	303
Halton	232	326	94
Hamilton-Wentworth	304	361	57
Total	2,710	3,833	1,123

Regional Municipality	Daily Transit Trips (Thousands of Trips) 1986	2001	Change in Trips 1986 to 2001
Metro	520	539	19
Durham	27	53	26
York	40	66	26
Peel	62	101	39
Halton	23	35	12
Hamilton-Wentworth	49	56	7
Total	721	850	129

Table 4.3 presents 24-hour[5] work trip rates per capita for each regional municipality, disaggregated by mode (total, auto, transit)[6] and gender (total, male, female). Points to note from this table include:

1. Both male and female work trip rates peak in 2001 and then decline slightly by 2011. This reflects the aging of the population, with a greater number of workers retiring from the labour force than the number of young workers entering the labour force.

2. Despite this peaking phenomenon, 2011 work trip rates are projected to be generally higher than 1986 values. The lone exception to this is female workers living in Metro, for whom the 2011 work trip rate is virtually identical to the 1986 value. This reflects the relatively high level of the current female labour force participation rate among Metro women which leaves little growth potential for this group relative to women living in the non-Metro regions.

3. The auto work trip rates follow the total trip rate pattern, with 2001 rates generally higher than the 2011 rates, but with the 2011 rates still being higher than the 1986 base rates (even within Metro).

4. The transit trip rates, on the other hand, display a more complex pattern. The rates for females actually decline somewhat over the 1986-2011 period for women living in Metro, York and Peel, remain constant for females in Halton, and increase somewhat for women living in Durham and Hamilton-Wentworth. The transit trip rates for men, on the other hand (and perhaps somewhat surprisingly), increase in all regions except Peel and Halton. The net outcome of these changes is relatively minor changes in the aggregate transit work trip rates. Further, where increases in these trip rates occur, they tend to be attributable largely to increases in the male trip rates, rather than the female rates, representing somewhat of a reversal of usual expectations.

Table 4.4 presents the changes in 24-hour work trip origin-destination flows from 1986 to 2001 for the six regional municipalities, broken down by all modes (including walk/other), auto

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[5] Peak period results are consistently very similar to the 24-hour results and so, for the sake of brevity, are not shown here. Although peak period numbers are generally the more relevant ones for most planning purposes, their generation does require the introduction of one addition modelling step (and associated assumptions and errors): the splitting of total trips into peak and off-peak time periods. For the purpose of the current discussion, it was felt that 24-hour totals might be more useful (and accurate) indicators of total trip-making activity. The model does, however, also generate peak-period work trips as part of its output (see Section 3.3.2).

[6] The "all modes" case includes walk plus "other" modes. Thus, the relevant cells in parts b and c of Table 4.2 sum to a number which is less than that shown in part a.

Table 4.3

24-Hour Work Trip Rates Per Capita, Base Scenario

A. All Modes (Including Walk/Other)

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.409	0.436	0.430	0.461	0.509	0.510	0.358	0.369	0.357
Durham	0.354	0.425	0.390	0.440	0.513	0.471	0.268	0.337	0.308
York	0.372	0.430	0.418	0.454	0.519	0.506	0.293	0.340	0.330
Peel	0.402	0.445	0.426	0.465	0.525	0.507	0.339	0.365	0.345
Halton	0.371	0.429	0.411	0.452	0.522	0.503	0.290	0.338	0.322
Hamilton-Went	0.323	0.414	0.406	0.392	0.500	0.496	0.257	0.332	0.321

B. Auto Mode

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.249	0.276	0.270	0.330	0.372	0.370	0.172	0.187	0.179
Durham	0.312	0.374	0.343	0.402	0.465	0.428	0.225	0.282	0.259
York	0.324	0.377	0.366	0.414	0.472	0.459	0.236	0.282	0.272
Peel	0.342	0.386	0.368	0.420	0.480	0.461	0.265	0.293	0.275
Halton	0.328	0.387	0.367	0.412	0.484	0.462	0.245	0.292	0.275
Hamilton-Went	0.263	0.339	0.334	0.343	0.441	0.439	0.186	0.241	0.235

C. Transit

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.137	0.140	0.139	0.110	0.117	0.120	0.163	0.161	0.157
Durham	0.026	0.034	0.029	0.023	0.030	0.026	0.029	0.037	0.032
York	0.038	0.039	0.038	0.032	0.034	0.034	0.045	0.045	0.043
Peel	0.048	0.043	0.044	0.037	0.034	0.035	0.059	0.053	0.053
Halton	0.030	0.027	0.028	0.031	0.025	0.027	0.029	0.028	0.029
Hamilton-Went	0.038	0.047	0.045	0.028	0.035	0.034	0.046	0.059	0.056

Table 4.4

Changes in 24-Hour Work Trip O-D Flows, 1986 to 2001,
Base Scenario

A. All modes (Including Walk/Other) (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	54.4	1.9	43.6	35.8	1.8	0.0	137.5
Durham	33.0	72.4	9.3	3.1	0.1	0.0	117.9
York	48.4	1.4	85.3	13.2	0.3	0.0	148.6
Peel	27.7	0.0	8.2	139.8	4.9	0.7	181.3
Halton	4.4	-0.1	0.6	17.3	44.0	3.6	69.8
Hamilton-Wentworth	0.5	-0.1	0.1	2.1	12.0	45.9	60.5
Total	168.4	75.5	147.1	211.3	63.1	50.2	715.6

B. Auto Mode (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	33.7	1.9	36.6	32.8	1.4	0.0	106.4
Durham	25.9	64.8	9.2	3.1	0.1	0.0	103.1
York	39.8	1.3	77.0	13.0	0.3	0.0	131.4
Peel	20.8	0.0	8.0	122.9	4.9	0.7	157.3
Halton	4.0	-0.1	0.2	17.2	39.7	3.6	64.6
Hamilton-Wentworth	0.3	-0.1	0.1	2.1	11.6	36.2	50.2
Total	124.5	67.8	131.1	191.1	58.0	40.5	613.0

C. Transit (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	20.7	-0.1	6.8	3.0	0.4	0.0	30.8
Durham	7.1	3.0	0.0	0.0	0.0	0.0	10.1
York	8.5	0.0	3.5	0.2	0.0	0.0	12.2
Peel	1.9	0.0	0.2	9.9	0.1	0.0	12.1
Halton	0.5	0.0	0.3	0.1	1.6	0.1	2.6
Hamilton-Wentworth	0.2	0.0	0.0	0.0	0.4	5.9	6.5
Total	38.9	2.9	10.8	13.2	2.5	6.0	74.3

mode and transit.[7] Points to note from this table include:

1. Peel, Metro and York are, respectively, the three largest attractors and generators of new work trips.

2. A considerable proportion (62%) of the growth in work trip flows is projected to be "self-contained" intra-regional trips.

3. Metro is the only regional municipality with significant growth in inter-regional flow. In total, inter-regional flow among the other five regional municipalities accounts for only 11% of the projected growth in work trip flows.

4. The growth in out-commuting from Metro to the other regions is almost as large as the growth of in-commuting from these regions to Metro (83,100 versus 114,000). Collectively, the cross-Metro boundary flows account for 28% of the total growth in work trip commuting during the 1986-2001 period.

5. 86% of the growth in work trip flows use the auto mode. The origin-destination pattern of the auto work trip flows generally mirrors that of the total trip matrix. Thus, 27% of the increase in auto work trips are cross-Metro boundary trips and 61% of the auto work trips are intra-regional trips.

6. The projected increases in transit work trips are relatively small. The single biggest source of increased transit trips are cross-Metro boundary trips (28,300, both directions) which account for 38% of the total increase. Intra-Metro trips account for 28% of the total increase, but are numerically small (20,700 round trips per day) when compared to current average weekday ridership levels on the TTC. Increases in other intra-regional transit trips are numerically small (Peel is the largest at 9,900), but may in some case still be large relative to current ridership levels on the given local transit system.

Comparing the row totals for the increases in transit work trip per origin regional municipality with the comparable numbers in Table 4.2 for total transit trips leads to two observations:

7. The increase in transit work trips for Metro is larger than the total increase in daily Metro transit trips (30,800 versus 19,000). This implies a net decrease in non-work transit trips occuring within Metro over this time period.

8. The differences between the total transit trip increases and the work transit trip increases for the regions other than Metro and Hamilton-Wentworth are relatively large, indicating significant increases in the number of daily non-work transit trips in these four regions.

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[7] Similar results for 2011 are presented in Appendix I.

It is not clear at this time how credible either of these two results are, particularly given the simplistic treatment given to non-work modal splits in the current model (see Section 3.3.3). Thus, further investigation of this issue is warranted before too much significance is attached to these results. To the extent, however, that they may, in fact, tend to over-estimate non-work transit travel in the aggregate, it may be that the 2001 (and 2011) aggregate auto modal splits should be somewhat higher than those reported in Table 4.1. Most of these non-work trips, however, are likely to be off-peak trips, implying that this uncertainty concerning the non-work modal splits is unlikely to alter the overall conclusions drawn from this analysis.

In summary, the base scenario indicates considerable increases in both auto and transit usage, but particularly in auto usage, over the forecast period. This increased usage is the result of both increased population and employment levels and increased trip rates (principally auto work trip rates). The "good news" in these results is that these increases in auto trip rates are not as large as one might have expected, apparently due to the interaction of several demographic, spatial, and modal effects that combine to keep the aggregate modal splits relatively constant over time. This result, however, clearly depends upon the assumption that regional and inter-regional transit services (particularly outside of Metro) evolve over time in step with the increasing levels of "densification" or "urbanization" that are projected to occur in the various regions. If these improvements in transit service do not occur, then clearly the loads on the road network will be even larger than those presented here. On the other hand, this analysis also explicitly ignores the effects which increasing road congestion might have on auto usage.

The largest growth in trip-making is projected to occur in the regions of Peel and York, but numerically significant growth is expected to occur in the other regions as well (except Hamilton-Wentworth, where more modest growth levels are expected), including Metro Toronto. Much of this growth in trip-making can be expected to be "self-contained" or intra-regional in nature, but a significant portion of the growth will also involve two-directional "cross-boundary" trips between Metro and the surrounding regions.

Again, a majority of the growth in both the intra-regional and the cross-boundary trips is expected to be auto-based, although a relatively large numerical increase in cross-boundary transit trips is also projected. Also, in some non-Metro regions, the projected growth in the number of intra-regional transit trips may be large relative to current transit usage levels.

Finally, the period 1986-2001 is projected to involve relatively rapid growth in travel demand, with the 2001-2011 time period generally producing a lower rate of growth. This reduced growth rate in the later time period is due both to a slowing in population and employment growth rates and, in some cases, to a reduction in per capita trip-making rates as well.

4.3.2 Scenario 1: "Centralization"

Table 4.5 presents the changes in the 2001 and 2011 total trips by regional muncipality projected for Scenario 1 relative to the trip totals projected for the base scenario (cf. Tables 4.1 and 4.2). Not surprisingly, the shifting of population and employment from the non-Metro regions into Metro results in an increased number of trip origins within Metro and decreases elesewhere. Breaking these changes down by mode, indicates that there is a significant increase in Metro-based transit trips relative to the base scenario, but only relatively minor decreases occur in non-Metro transit trip-making, resulting in an overall net increase in daily GTA transit trips of 43,000 in 2001 and 82,000 in 2011. On the other hand, significant decreases in auto trip-making in non-Metro regions more than compensate for increased auto usage within Metro, leading to net decreases in daily GTA auto trips of 67,000 in 2001 and 114,000 in 2011. Since the net decrease in auto trips is larger in magnitude than the increase in transit trips, there is an overall decrease in total daily trip-making in Scenario 1 relative to the base case. This difference in total trip-making between the two scenarios largely reflects the increased number of Metro-based walk trips which would occur under Scenario 1 but which are not captured in the table.

Table 4.6 presents the changes in regional 24-hour work trip origin-destination flows for 2001 relative to 1986 for Scenario 1. Thus, it is comparable to Table 4.4 for the base scenario. Comparing these two tables results in the following observations:

1. The 1986-2001 growth in intra-Metro work trips is projected to more than double (155% increase) under Scenario 1 relative to the base scenario.

2. The growth in "out-commuting" from Metro to the surrounding regions is projected to decrease slightly under Scenario 1 relative to the base case, while the growth in "in-commuting" is projected to increase by an even smaller amount. The net result is that total growth in two-way cross-boundary work trip flows projected under Scenario 1 is marginally less (190,300 trips versus 197,100) than under the base scenario.

3. The number of non-Metro to non-Metro trips are proportionately reduced.

Table 4.5

Changes in Predicted Regional Trip Origins,
Scenario 1 - Base Scenario

Regional Municipality	Total Trips 2001	Total Trips 2011	Auto Trips 2001	Auto Trips 2011	Transit Trips 2001	Transit Trips 2011
Metro	122	175	64	79	57	96
Durham	-28	-39	-25	-35	-3	-4
York	-44	-67	-41	-64	-4	-3
Peel	-45	-62	-40	-57	-5	-5
Halton	-18	-29	-16	-27	-1	-1
Hamilton-Wentworth	-11	-11	-9	-10	-1	-1
Total	-24	-33	-67	-114	43	82

NOTE: All numbers expressed in terms of thousands of daily trips. A positive number indicates an increase relative to the base scenario value.

Table 4.6

Changes in 24-Hour Work Trip O-D Flows, 1986 to 2001, Scenario 1

A. All modes (Including Walk/Other) (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	138.5	1.7	39.2	30.8	1.3	-0.2	211.3
Durham	32.5	60.5	7.5	2.4	0.0	0.0	102.9
York	48.6	1.0	68.5	10.2	0.1	0.0	128.4
Peel	27.9	0.0	6.9	113.4	3.5	0.2	151.9
Halton	6.8	-0.1	0.5	15.7	36.2	1.9	61.0
Hamilton-Wentworth	1.7	0.0	0.1	2.6	12.2	39.0	55.6
Total	256.0	63.1	122.7	175.1	53.3	40.9	711.1

B. Auto Mode (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	68.9	1.7	32.4	27.8	0.9	-0.2	131.5
Durham	25.4	54.5	7.5	2.4	0.0	0.0	89.8
York	39.6	1.0	61.8	10.0	0.1	0.0	112.5
Peel	24.0	0.0	6.7	100.7	3.4	0.2	135.0
Halton	5.5	-0.1	0.2	15.5	32.7	1.8	55.6
Hamilton-Wentworth	1.1	0.0	0.1	2.5	11.8	30.7	46.2
Total	164.5	57.1	108.7	158.9	48.9	32.5	570.6

C. Transit (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	60.2	0.0	6.5	3.0	0.3	0.0	70.0
Durham	7.0	2.3	0.0	0.0	0.0	0.0	9.3
York	8.9	0.0	2.8	0.2	0.0	0.0	11.9
Peel	3.8	0.0	0.2	7.6	0.1	0.0	11.7
Halton	1.3	0.0	0.3	0.1	1.3	0.0	3.0
Hamilton-Wentworth	0.7	0.0	0.0	0.0	0.4	5.1	6.2
Total	81.9	2.3	9.8	10.9	2.1	5.1	112.1

4. The auto trip flows mirror the total flow results, with the growth in intra-Metro auto trips increasing by 104% and the growth in cross-boundary trips (both directions) decreasing marginally (158,300 trips versus 163,500).

5. The growth in intra-Metro transit (TTC) trips are projected to increase by 191% under Scenario 1 relative to the base scenario. The growth in cross-boundary transit trips is also projected to be slightly larger under Scenario 1 (31,500 versus 28,300). The changes in non-Metro to non-Metro transit trips are generally not as large proportionally as in the auto case.

Thus, Scenario 1 achieves a net reduction in auto travel and a net increase in transit usage within the GTA that are significant in magnitude. The reduction in auto travel occurs entirely within non-Metro regions. The "price" paid for this reduction, however, is considerably more traffic being loaded on Metro roads. Whether the Metro road system could accomodate (or be upgraded to accomodate) such an increased load is not answerable within this study, but is obviously central to the evaluation of this scenario. Alternatively, means might be found to divert more intra-Metro trips onto transit than is assumed in the current model as a way of reducing the load on the road system. Volume I discusses this issue with respect to the case of work trip flows destined to Planning District 1, and concludes that opportunities for such improvements in transit modal splits may well exist (despite the relatively high transit modal splits already being achieved), primarily because of the relatively dense network of services already provided by the TTC, which might be cost-effectively improved to attract new riders.

The increase in transit usage is largely intra-Metro in composition, with some compensating decreases in the intra-regional transit usage in the other regional municipalities. This implies the need to invest relatively more heavily in TTC service and/or infrastructure improvements and relatively less in other local transit services.

Finally, Scenario 1 is relatively neutral in its impact on cross-Metro boundary flows. Increases in cross-boundary auto trips are projected to be marginally smaller, while increases in cross-boundary transit trips (principally GO Transit riders) are projected to slightly larger relative to the base case. Thus, the need for improved inter-regional transit services is, if anything, enhanced under this scenario, while the cross-boundary road traffic problem does not appear to be significantly worsened (but it is also not significantly improved).

4.3.3 Scenario 2: "Densification"

Table 4.7 presents the differences in projected total trips, auto trips, and transit trips by regional municipality between Scenario 2 and the base case. As indicated by this table, this scenario generates somewhat greater reductions in daily auto trips than Secenario 1 while generating only very modest increases in total transit trips.

Table 4.8 presents the changes in 2001 24-hour work trip O-D flows on a regional municipality basis relative to the 1986 case. Comparing this table with the comparable base case table (Table 4.4) indicates that very little modal shift in work trips is generated by this scenario relative to the base scenario. Auto work trips decrease by only 5,100, while transit work trips increase by only 3,900. Further, the general distribution of work trip flows is virtually unaltered. Thus, this scenario appears to accomplish very little in terms of reducing work trip commuting loads on the GTA transportation system.

The modal shifts indicated in Table 4.7 are, therefore, due almost entirely to two shifts in non-work trip-making: a relatively modest one from auto to transit, and a more significant one from auto to walk/other modes (reflecting the increased density of walk trip opportunities generally available under this scenario). While this is encouraging, the simplicity of the non-work trip modal split relationships used in this model imply that considerable caution is warranted in assessing the impact of this scenario on modal usage.

4.3.4 Scenario 3: "Self-Containment"

Table 4.9 presents the differences in projected total trips, auto trips, and transit trips by regional municipality between Scenario 3 and the base case. As indicated by this table, there is virtually no difference between the two scenarios in terms of total GTA daily trip-making. This net null result, however, represents the combination of a modest increase in auto trips which is more or less compensated for by a decrease in transit trips. The auto trip increase is largely due to an increase in Metro-based auto trips, although marginal increases in auto trips also are generally projected for the other regions. All regions are projected to experience reduced numbers of transit trips under this scenario (except for Hamilton-Wentworth in which no net change occurs), but with the bulk of the decrease occuring within Metro.

Table 4.7

Changes in Predicted Regional Trip Origins, Scenario 2 - Base Scenario

Regional Municipality	Total Trips 2001	Total Trips 2011	Auto Trips 2001	Auto Trips 2011	Transit Trips 2001	Transit Trips 2011
Metro	2	-1	-1	-3	2	2
Durham	-12	0	-16	-8	4	8
York	-21	-43	-25	-54	4	11
Peel	-15	-34	-20	-39	6	4
Halton	-7	-16	-8	-20	2	5
Hamilton-Wentworth	-3	-3	-3	-4	0	1
Total	-56	-97	-73	-128	18	31

NOTE: All numbers expressed in terms of thousands of daily trips. A positive number indicates an <u>increase</u> relative to the base scenario value.

Table 4.8

Changes in 24-Hour Work Trip O-D Flows, 1986 to 2001, Scenario 2

A. All modes (Including Walk/Other) (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	52.0	1.8	46.0	35.2	1.4	0.1	136.5
Durham	33.4	72.6	11.0	3.0	0.1	0.0	120.1
York	50.9	1.2	82.8	12.8	0.2	0.0	147.9
Peel	22.6	0.1	6.4	140.6	4.0	0.7	174.4
Halton	4.0	-0.1	0.6	17.8	43.9	4.2	69.8
Hamilton-Wentworth	0.4	-0.1	0.0	2.0	13.6	45.4	61.3
Total	163.3	75.5	146.8	211.4	62.9	50.4	710.3

B. Auto Mode (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	30.1	1.8	38.1	32.2	1.0	0.0	103.2
Durham	26.1	64.9	10.9	3.0	0.1	0.0	105.0
York	41.3	1.1	73.9	12.6	0.2	0.0	129.1
Peel	20.4	0.1	6.2	123.6	3.9	0.7	154.9
Halton	3.7	-0.1	0.2	17.6	39.4	4.1	65.1
Hamilton-Wentworth	0.2	-0.1	0.0	2.0	13.1	35.6	50.8
Total	121.8	67.7	129.3	191.0	57.7	40.4	607.9

C. Transit (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	21.6	-0.1	7.6	3.1	0.3	0.0	32.5
Durham	7.2	3.1	0.1	0.0	0.0	0.0	10.4
York	9.5	0.0	3.8	0.2	0.0	0.0	13.5
Peel	2.2	0.0	0.2	10.0	0.1	0.0	12.5
Halton	0.4	0.0	0.4	0.1	1.7	0.1	2.7
Hamilton-Wentworth	0.2	0.0	0.0	0.0	0.4	6.0	6.6
Total	41.1	3.0	12.1	13.4	2.5	6.1	78.2

Table 4.9

Changes in Predicted Regional Trip Origins, Scenario 3 - Base Scenario

Regional Municipality	Total Trips 2001	Total Trips 2011	Auto Trips 2001	Auto Trips 2011	Transit Trips 2001	Transit Trips 2011
Metro	-1	-6	21	20	-23	-26
Durham	-8	2	-4	5	-4	-3
York	3	2	5	5	-4	-3
Peel	2	-3	6	1	-1	-4
Halton	0	-5	3	-3	-1	-3
Hamilton-Wentworth	1	2	2	2	0	0
Total	-3	-8	33	30	-35	-39

NOTE: All numbers expressed in terms of thousands of daily trips. A positive number indicates an increase relative to the base scenario value.

Table 4.10 presents the changes in regional 24-hour work trip O-D flows relative to 1986 conditions. Comparing this table with the comparable base scenario table (Table 4.4), leads to the following observations:

1. The increase in intra-Metro trips is significantly reduced (54,400 trips to 9,800 trips), as are the cross-boundary trips into Metro (114,000 trips to 45,000 trips). The increase in outbound cross-boundary trips, however, increases significantly under this scenario (up to 129,700 trips from 83,100).

2. The increases in intra-regional flows in the other regions, as expected, increase significantly under this scenario.

3. Taking all six regions together, however, the net increase in intra-regional work trip commuting is only 2% of the total increase in work trips (64% versus 62% under the base scenario). Thus, little net improvement in self-containment is achieved under this scenario. Rather, it results in a shifting of much of Metro's self-containment outwards, into the other regions.

4. Although the amount of two-way cross-boundary flow into and out of Metro is reduced somewhat under this scenario (an increase of 174,700 daily trips versus 197,100 under the base scenario), the increase in the number of two-way auto trips across the Metro boundary is changed only marginally (156,300 trips versus 163,500). Thus, the magnitude of the road "cross-boundary problem" is not significantly changed by this scenario. Rather, the nature of the problem is altered to one involving a greater degree of out-commuting relative to the base scenario.

5. The increase in transit work trips is reduced by 41% relative to the base scenario (43,900 trips versus 74,300). Intra-Metro transit trips are actually projected to decrease by 2,700 trips per day under this scenario, while the increase in two-way cross-boundary transit trips is reduced from 28,300 trips per day to only 12,500 daily trips. Largely because of this reduction in transit trips into Metro, the increase in transit trips originating in every regional municipality is less under this scenario relative to the base case.

Thus, this scenario -- as currently specified -- appears to accomplish little. It generates only a very modest increase in intra-regional commuting, and it does so by actually reducing the self-containment of the largest of the six regional municipalities, Metro Toronto. It also results in modest but significant increases in auto usage and decreases in transit usage.

The effectiveness of this scenario might be improved by shifting population growth along with the employment growth out of Metro and into the other regions. Such a scenario would represent a more exact "mirror image" of Scenario 1, would presumably generate greater increases in self-containment in these regions (without forcing Metro workers to commute out in search of

Table 4.10

Changes in 24-Hour Work Trip O-D Flows, 1986 to 2001, Scenario 3

A. All modes (Including Walk/Other) (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	9.8	8.4	62.3	54.1	4.2	0.7	139.5
Durham	13.2	87.1	8.1	2.8	0.1	0.0	111.3
York	31.2	2.8	98.9	15.7	0.4	0.0	149.0
Peel	3.4	0.3	8.7	156.5	7.4	1.4	177.7
Halton	-1.7	0.0	0.4	15.6	51.4	4.8	70.5
Hamilton-Wentworth	-1.1	-0.1	0.0	1.4	12.3	49.0	61.5
Total	54.8	98.5	178.4	246.1	75.8	55.9	709.5

B. Auto Mode (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	15.9	8.2	52.5	49.6	3.6	0.6	130.4
Durham	10.8	77.9	8.1	2.8	0.1	0.0	99.7
York	26.5	2.7	89.1	15.4	0.4	0.0	134.1
Peel	5.6	0.3	8.4	137.0	7.3	1.4	160.0
Halton	-0.4	0.0	0.1	15.5	46.3	4.7	66.2
Hamilton-Wentworth	-0.7	-0.1	0.0	1.4	1.8	38.7	51.1
Total	57.7	89.0	158.2	221.7	69.5	45.4	641.5

C. Transit (Thousands of Daily Trips)

Origin Region	Destination Region Metro	Durham	York	Peel	Halton	Ham-W	Total
Metro	-2.7	0.1	9.5	4.5	0.6	0.0	12.0
Durham	2.5	3.6	0.0	0.0	0.0	0.0	6.1
York	4.7	0.0	4.1	0.2	0.0	0.0	9.0
Peel	-2.3	0.0	0.2	11.3	0.2	0.0	9.4
Halton	-1.3	0.0	0.3	0.1	1.9	0.1	1.1
Hamilton-Wentworth	-0.4	0.0	0.0	0.0	0.4	6.3	6.3
Total	0.5	3.7	14.1	16.1	3.1	6.4	43.9

jobs). and would possibly generate the higher densities in the non-Metro regions that facilitate improved transit services within these regions.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This report documents the development of a model of aggregate GTA travel demand that can be used to explore the transportation implications of a range of future scenarios. Important features of this model include:

1. It is based on observed travel behaviour as captured within the 1986 Transportation Tomorrow Survey (TTS) database. In general the model assumes that the 1986 behavioural relationships will hold in the future, although scenarios incorporating alternative behavioural assumptions could be implemented, if desired, within the model.

2. It explicitly incorporates demographic factors (age-sex profiles of the resident population) -- and the evolution of these factors over time -- into the travel demand calculations. In particular, labour force participation rates, work trip rates, work trip modal choice, and non-work trip rates by mode are all functions of the gender and/or age of the trip-makers involved.

3. It explicitly incorporates spatial factors (level of urbanization) into the calculations. A measure of "urban density" is used to categorize TARMS zones. Labour force participation rates, demographic profiles, work trip modal choice, and non-work trip rates by mode all depend on this term.

While in principle virtually any element of the model's input data and/or underlying behavioural assumptions could be altered within the specification of a future scenario to be tested, in this study only scenarios involving the spatial redistribution of the future growth in population and/or employment were examined. In particular, four scenarios were considered:

1. the base case, defined by current MTO projections of population and employment by TARMS zones for the years 2001 and 2011;

2. a "centralization" scenario, in which the base case projected growth in population and employment is redistributed so as to increase the growth within Metro Toronto and proportionately decrease the growth outside of Metro Toronto;

3. a "densification" scenario, in which the base case projected growth in population and employment is redistributed within each regional municipality within the Greater Toronto Area (GTA) so as focus this growth within existing "urbanized" areas, with proportionately less growth occuring in currently rural or lower density areas; and

4. a "self-containment" scenario, in which the base case projected growth in Metro-based employment is reallocated so that more employment growth occurs in the non-Metro regions within which the larger proportions of population growth are projected.

Analysis of the base scenario results leads to the following observations:

1. Considerable increases in both auto and transit usage are projected, but particularly in auto usage. These increases result both from increased population and employment levels as well as from increased trip rates per person (particularly auto work trip rates).

2. The largest gorwth in trip-making is projected to occur in the regions of York and Peel, but significant growth is expected to occur in the other regions as well, including Metro.

3. Much of the growth (62% of work trip flows) in travel is projected to be intra-regional in nature. A significant portion of the growth, however, involves two-directional "cross-boundary" trips between Metro Toronto and the surrounding regions (little inter-regional interaction among the non-Metro regions is projected).

4. A significant majority of the growth in both intra-regional and cross-boundary trips is expected to be auto-based.

5. A numerically large increase in cross-boundary transit trips is also projected. The increase in intra-Metro transit trips is relatively modest (20,000 work trips per day) compared to the current magnitude of TTC ridership. The projected growth in non-Metro intra-regional transit trips may, in some cases, be large relative to current transit usage levels. In particular, the projected transit usage assumes increases in intra- and inter-regional transit services which are commensurate with the projected increased levels of urbanization throughout the GTA.

6. The 1986-2001 period is projected to experience higher growth rates than the 2001-2011 period, both due to a projected slowing in population and employment growth during the latter period and due to a reduction in per capita trip rates (due to demographic shifts, etc.) as well.

The centralization scenario is projected to result in a significant reduction in the total number of auto trips generated within the GTA combined with a significant increase in the total number of transit trips made. The net decrease in auto trips, however, is the result of an even larger decrease in auto trips outside of Metro combined with a significant increase in auto trips being generated within the Metro boundaries. Similarly, the transit increase largely consists of intra-Metro trips, although cross-boundary transit trips also increase by a modest amount, and the decline in non-Metro intra-regional transit trips is not proportionately as large as in the auto trip

case. Thus, this scenario may result in a more "efficient" transportation system (higher transit usage, fewer long distance auto trips), but it involves introducing significant additional loads on the already heavily loaded Metro transportation system (particularly the road network). Thus, the technical feasibility of this form of future development requires careful scrutiny.

The densification scenario is projected to have virtually no impact on work trip commuting patterns or modal usage. It is projected to have a significant impact on non-work travel (reduced auto trips, modest increase in transit trips), but this result requires further investigation before being accepted at face value given the very simplistic treatment of non-work modal split in the current version of the model.

Finally, the self-containment scenario as tested in this study appears to accomplish relatively little. It generates only a very modest increase in the amount of "self-contained" intra-regional work trip commuting, while at the same time it actually increases the amount of out-commuting from Metro relative to the base case. It also results in a more auto-oriented travel pattern than the base case and is projected to actually generate a small reduction in work-based TTC travel. It appears that even more population growth in the non-Metro regions than that projected by the base case (and hence a proportionately smaller population growth within Metro) would be required to achieve significant increases in self-containment relative to that achieved by the base case.

All three scenarios examined involve relatively large (and perhaps politically and/or economically infeasible) redistributions of current best estimates of the GTA's development trends. Certainly considerable effort (and cooperation) on the part of governments at all levels (local, regional, provincial) would likely be required to effectively implement any of the alternative scenarios required. The purpose of this study is not to promote any one of these alternative scenarios as desirable public policy. Rather, it is simply to explore the transportation implications of alternative land use configurations within a "what if" experimental framework, in order to provide some additional inputs into the policy formulation process.

Regardless of the land use scenario considered, if the overall levels of population and employment growth projected for the GTA through to the year 2011 are at all reasonable, then clearly significant increases in trip-making activity can be anticipated to be added to an already heavily loaded transportation system. This is particularly true of the road system, but inter-regional transit and intra-regional transit systems (most notably, but not exclusively the TTC) will all require

continuing improvement if they are to keep pace with the projected demand and if they are to provide an effective alternative to the congested road system.

Actively altering the evolution of land use within the GTA does alter the GTA-wide travel patterns, but fairly significant deviations from the base trend would appear to be required in order to generate significant impacts. Scenario 1 ("centralization") illustrates this point in that a reallocation of 15% of the projected non-Metro growth to Metro zones is estimated to result in a reduction of more than 100,000 auto round trips per weekday by the year 2011, while increasing the number of transit round trips per weekday by about 80,000 during this same time period. These are non-trivial changes in travel demand, but at the same time the hypothesized shift in both population and employment growth patterns is also non-trivial to accomplish -- both in terms of Metro's ability to attract and absorb this increased growth and in terms of the non-Metro regions' ability/willingness to help such a shift occur.

As is also illustrated by Scenario 1, shifts in land use development may well simply shift travel problems rather than ameliorate them. For example, the GTA-wide reduction in auto trip-making projected for Scenario 1 is accompanied by an actual increase in auto travel on Metro roads. Again, the overall magnitude of development within the GTA tends to determine the overall magnitude of travel demand, and restructuring of this development, while quite possibly worthwhile in terms of producing a more efficient, effective transportation - land use interaction, can ultimately only go so far in terms of reducing the absolute amount of travel being generated.

This study did not investigate the impacts of such obviously important factors as congestion effects on auto usage (principally modal split, but also trip distribution and even trip generation can be affected by congestion), strategies for improving transit service to increase transit modal splits (particularly for non-Toronto Central Area trips), and "feedback" effects of road and transit congestion on the location and magnitude of economic activities (particularly employment, but also housing). In particular, it is may well be that the levels of auto usage projected by this model simply will not occur, because people will switch to transit, or travel to other, less congested locations, or not make the trip, or live and work in some other urban area, before making the auto trips projected here under such extreme levels of congestion.

The study also did not explicitly investigate the potential impacts of deviations from current labour force participation rates, household structures, etc., except to the extent that is captured in

the "base" demographic forecasts used throughout the analysis. Clearly more detailed analyses can and should be undertaken with respect to such factors. The feeling one gets from the analysis performed to date, however, is that the impacts of changes in such factors is likely to be of somewhat secondary importance relative to heavy momentum provided to the system by the "fundamental" land use - transportation interactions and trends.

While the model as developed within this study appears to be generating useful and interesting aggregate travel projections, it is still in most respects in a very preliminary and relatively simplistic state of development. Thus, the numbers presented within this report should certainly be treated as "illustrative" rather than in way "definitive". Further, several incremental improvements to the current model should be seriously considered before it is used to investigate a wider range of scenarios or to explore any one scenario in considerably more detail. These include:

1. A better linkage between the demographic (age-sex distributions) and land use (population and employment distributions) components is required. At the moment, population shifts from one part of the GTA to another do not alter the underlying demographic profiles in the affected regions -- an overly simplistic assumption. Put another way, the specification of a scenario should involve explicit consideration of how the regional demographic profiles need to be altered to maintain logical consistency -- something which was not done in this study.

2. An improved representation of modal split is required, in particular, one which is in some way sensitive to at least simple measures of road and transit service levels so that shifts in mode splits over time can be more reasonably represented.

3. An improved work trip distribution model is required that is better able to adjust to significant shifts in population and employment distributions than the current entropy/"Fratar" updating procedure is.

4. Considerably more investigation into the measurement and role of "urban density" is required. This includes more detailed comparison of density measures versus "accessibility" measures in terms of relative explanatory powers. The concept of urban density has been found within this study to be a promising means of "quantifying" urban structure in a way which can be used to help explain spatial variations in travel behaviour, but more research is required to achieve a full understanding of the concept and its ultimate usefulness within travel demand modelling.

5. The model as currently constructed consists of a rather unwieldly Fortran 77 program resident on a large mini-computer combined with miscellaneous Lotus 1-2-3 procedures resident on a micro-computer for pre- and post-processing the model's data inputs and outputs and for generating standard tabular outputs. Ideally, the model should be "cleaned up" to make it both more user-friendly and more flexible

in its applications. It also should probably be transferred completely to the micro-computer environment to enhance its portability.

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APPENDIX A

LABOUR FORCE PARTICIPATION RATES BY AGE BY GENDER BY DENSITY CLASS

This appendix contains tables of labour force participation rates per person for four labour force categories: full-time worker, part-time worker, work at home, and "other". This rates are provided for each age category (expressed in five year age groupings; the number shown under "age" in the tables is the upper bound of each age group), by gender (male, female, total), for each zonal density class.

DENSITY CLASS 1

age	Full-Time Worker Male	Full-Time Worker Female	Full-Time Worker Total	Part-Time Worker Male	Part-Time Worker Female	Part-Time Worker Total
20	0.241	0.192	0.217	0.248	0.285	0.266
25	0.790	0.637	0.723	0.069	0.117	0.090
30	0.921	0.545	0.728	0.002	0.132	0.069
35	0.911	0.411	0.649	0.005	0.214	0.115
40	0.914	0.491	0.698	0.019	0.198	0.110
45	0.908	0.494	0.713	0.003	0.169	0.081
50	0.882	0.447	0.662	0.010	0.158	0.085
55	0.844	0.341	0.616	0.014	0.130	0.067
60	0.709	0.221	0.456	0.025	0.089	0.058
65	0.416	0.080	0.258	0.036	0.064	0.049

DENSITY CLASS 2

age	Full-Time Worker Male	Full-Time Worker Female	Full-Time Worker Total	Part-Time Worker Male	Part-Time Worker Female	Part-Time Worker Total
20	0.170	0.179	0.174	0.284	0.312	0.298
25	0.760	0.682	0.721	0.078	0.125	0.101
30	0.927	0.555	0.728	0.028	0.139	0.087
35	0.965	0.503	0.717	0.008	0.133	0.075
40	0.968	0.541	0.752	0.008	0.181	0.096
45	0.965	0.566	0.779	0.002	0.157	0.074
50	0.943	0.433	0.705	0.006	0.179	0.087
55	0.912	0.379	0.654	0.012	0.160	0.084
60	0.793	0.248	0.516	0.014	0.118	0.067
65	0.448	0.091	0.264	0.041	0.073	0.057

DENSITY CLASS 1

age	Work @ Home Male	Work @ Home Female	Work @ Home Total	Other Male	Other Female	Other Total
20	0.010	0.003	0.007	0.501	0.520	0.510
25	0.018	0.019	0.019	0.123	0.226	0.169
30	0.032	0.034	0.033	0.045	0.289	0.171
35	0.050	0.031	0.040	0.035	0.343	0.197
40	0.029	0.028	0.028	0.038	0.283	0.163
45	0.062	0.046	0.054	0.028	0.291	0.151
50	0.056	0.041	0.048	0.053	0.354	0.205
55	0.078	0.055	0.068	0.064	0.474	0.250
60	0.111	0.060	0.084	0.155	0.630	0.402
65	0.053	0.048	0.051	0.495	0.807	0.642

DENSITY CLASS 2

age	Work @ Home Male	Work @ Home Female	Work @ Home Total	Other Male	Other Female	Other Total
20	0.000	0.006	0.003	0.545	0.503	0.525
25	0.016	0.008	0.012	0.146	0.186	0.166
30	0.010	0.017	0.014	0.036	0.288	0.171
35	0.009	0.038	0.025	0.019	0.326	0.184
40	0.010	0.027	0.019	0.013	0.251	0.134
45	0.008	0.027	0.017	0.025	0.250	0.130
50	0.018	0.051	0.033	0.033	0.337	0.175
55	0.021	0.033	0.027	0.055	0.427	0.235
60	0.034	0.016	0.025	0.159	0.618	0.392
65	0.031	0.018	0.024	0.480	0.818	0.655

DENSITY CLASS 3

age	Full-Time Worker Male	Female	Total	Part-Time Worker Male	Female	Total
20	0.207	0.174	0.190	0.313	0.308	0.310
25	0.743	0.643	0.694	0.082	0.129	0.105
30	0.936	0.591	0.748	0.015	0.114	0.069
35	0.948	0.493	0.704	0.009	0.154	0.087
40	0.956	0.548	0.746	0.007	0.169	0.090
45	0.962	0.513	0.749	0.008	0.210	0.104
50	0.942	0.506	0.736	0.006	0.188	0.093
55	0.900	0.405	0.654	0.021	0.161	0.091
60	0.782	0.270	0.543	0.020	0.116	0.065
65	0.435	0.123	0.272	0.048	0.083	0.066

DENSITY CLASS 3 (Metropolitan Toronto)

age	Full-Time Worker Male	Female	Total	Part-Time Worker Male	Female	Total
20	0.186	0.161	0.174	0.261	0.281	0.271
25	0.703	0.664	0.684	0.095	0.123	0.109
30	0.910	0.704	0.807	0.019	0.052	0.036
35	0.931	0.633	0.779	0.018	0.094	0.057
40	0.934	0.590	0.751	0.011	0.139	0.079
45	0.949	0.583	0.760	0.010	0.146	0.081
50	0.913	0.549	0.725	0.010	0.136	0.075
55	0.892	0.441	0.667	0.013	0.160	0.086
60	0.789	0.306	0.555	0.018	0.110	0.062
65	0.472	0.165	0.312	0.046	0.061	0.054

DENSITY CLASS 3

age	Work @ Home			Other		
	Male	Female	Total	Male	Female	Total
20	0.001	0.001	0.001	0.479	0.517	0.499
25	0.008	0.011	0.010	0.167	0.218	0.192
30	0.005	0.023	0.015	0.044	0.272	0.168
35	0.014	0.030	0.023	0.029	0.323	0.187
40	0.014	0.024	0.019	0.023	0.259	0.144
45	0.008	0.028	0.017	0.022	0.249	0.130
50	0.018	0.018	0.018	0.034	0.287	0.154
55	0.017	0.016	0.016	0.062	0.418	0.239
60	0.014	0.026	0.020	0.183	0.587	0.372
65	0.018	0.036	0.027	0.499	0.759	0.634

DENSITY CLASS 3 (Metropolitan Toronto)

age	Work @ Home			Other		
	Male	Female	Total	Male	Female	Total
20	0.000	0.001	0.001	0.554	0.556	0.555
25	0.000	0.014	0.007	0.202	0.200	0.201
30	0.006	0.019	0.013	0.065	0.225	0.145
35	0.008	0.017	0.013	0.042	0.256	0.151
40	0.015	0.032	0.024	0.040	0.240	0.147
45	0.013	0.020	0.017	0.028	0.251	0.143
50	0.019	0.020	0.020	0.059	0.294	0.180
55	0.019	0.029	0.024	0.075	0.370	0.222
60	0.016	0.021	0.018	0.178	0.564	0.365
65	0.024	0.021	0.022	0.459	0.752	0.612

DENSITY CLASS 4

age	Full-Time Worker Male	Full-Time Worker Female	Full-Time Worker Total	Part-Time Worker Male	Part-Time Worker Female	Part-Time Worker Total
20	0.191	0.184	0.188	0.262	0.305	0.282
25	0.728	0.670	0.698	0.096	0.115	0.105
30	0.905	0.664	0.781	0.031	0.090	0.062
35	0.926	0.591	0.752	0.015	0.121	0.070
40	0.932	0.641	0.780	0.011	0.125	0.070
45	0.932	0.629	0.779	0.012	0.130	0.072
50	0.905	0.572	0.728	0.016	0.137	0.080
55	0.868	0.455	0.660	0.017	0.139	0.078
60	0.762	0.293	0.532	0.024	0.126	0.074
65	0.441	0.160	0.289	0.033	0.069	0.052

DENSITY CLASS 5

age	Full-Time Worker Male	Full-Time Worker Female	Full-Time Worker Total	Part-Time Worker Male	Part-Time Worker Female	Part-Time Worker Total
20	0.203	0.200	0.202	0.233	0.271	0.252
25	0.711	0.637	0.673	0.100	0.121	0.111
30	0.867	0.690	0.777	0.044	0.094	0.069
35	0.879	0.657	0.767	0.026	0.107	0.067
40	0.887	0.649	0.767	0.025	0.107	0.067
45	0.894	0.624	0.751	0.025	0.125	0.078
50	0.869	0.553	0.706	0.015	0.109	0.063
55	0.852	0.488	0.674	0.014	0.105	0.058
60	0.727	0.307	0.508	0.029	0.101	0.066
65	0.417	0.180	0.283	0.047	0.068	0.059

DENSITY CLASS 6

age	Full-Time Worker Male	Full-Time Worker Female	Full-Time Worker Total	Part-Time Worker Male	Part-Time Worker Female	Part-Time Worker Total
20	0.260	0.211	0.234	0.232	0.279	0.258
25	0.664	0.631	0.647	0.089	0.145	0.118
30	0.834	0.742	0.788	0.058	0.084	0.071
35	0.910	0.752	0.833	0.025	0.058	0.041
40	0.883	0.698	0.792	0.016	0.095	0.055
45	0.889	0.665	0.784	0.021	0.085	0.051
50	0.867	0.624	0.741	0.015	0.087	0.052
55	0.820	0.583	0.702	0.027	0.064	0.045
60	0.653	0.420	0.538	0.043	0.103	0.073
65	0.379	0.176	0.256	0.066	0.096	0.084

DENSITY CLASS 4

age	Work @ Home Male	Work @ Home Female	Work @ Home Total	Other Male	Other Female	Other Total
20	0.001	0.002	0.001	0.546	0.510	0.529
25	0.004	0.007	0.006	0.173	0.208	0.191
30	0.006	0.014	0.010	0.058	0.231	0.147
35	0.016	0.026	0.021	0.043	0.262	0.156
40	0.015	0.020	0.017	0.043	0.215	0.133
45	0.012	0.023	0.018	0.044	0.219	0.132
50	0.013	0.011	0.012	0.066	0.280	0.180
55	0.019	0.024	0.022	0.096	0.383	0.240
60	0.019	0.023	0.021	0.194	0.558	0.373
65	0.010	0.020	0.015	0.516	0.751	0.644

DENSITY CLASS 5

age	Work @ Home Male	Work @ Home Female	Work @ Home Total	Other Male	Other Female	Other Total
20	0.000	0.006	0.003	0.563	0.524	0.543
25	0.004	0.007	0.006	0.186	0.235	0.211
30	0.005	0.018	0.012	0.084	0.198	0.141
35	0.021	0.023	0.022	0.074	0.213	0.144
40	0.018	0.020	0.019	0.070	0.224	0.147
45	0.018	0.020	0.019	0.064	0.230	0.152
50	0.019	0.026	0.022	0.098	0.313	0.209
55	0.028	0.025	0.027	0.106	0.382	0.241
60	0.007	0.024	0.016	0.238	0.568	0.410
65	0.012	0.023	0.018	0.523	0.728	0.639

DENSITY CLASS 6

age	Work @ Home Male	Work @ Home Female	Work @ Home Total	Other Male	Other Female	Other Total
20	0.000	0.004	0.002	0.507	0.506	0.507
25	0.002	0.002	0.002	0.245	0.222	0.233
30	0.017	0.016	0.016	0.091	0.159	0.124
35	0.019	0.033	0.026	0.045	0.157	0.100
40	0.052	0.024	0.038	0.049	0.183	0.115
45	0.023	0.042	0.032	0.068	0.209	0.134
50	0.011	0.024	0.018	0.107	0.265	0.190
55	0.027	0.041	0.034	0.126	0.313	0.219
60	0.028	0.019	0.024	0.276	0.458	0.366
65	0.015	0.005	0.009	0.541	0.723	0.651

APPENDIX B

THE WORK TRIP DISTRIBUTION MODEL

Define the following terms:

T_{ijk}^{t} = flow from i --> j by gender k workers in year t
$i = 1, \ldots, 46;$ $j = 1, \ldots, 46$

T_{ijk}^{p} = prior estimate of flow T_{ijk}

O_{ik}^{t} = total trip origins in zone i for gender k, year t

D_{j}^{t} = total trip destinations in zone j, year t

The entropy maximization problem is then given by:

$$\max_{\{T_{ijk}^{t}\}} S = -\sum_{i}\sum_{j}\sum_{k} T_{ijk}^{t} \log \left\{\frac{T_{ijk}^{t}}{T_{ijk}^{p}}\right\}$$

subject to :

$$\sum_{j} T_{ijk}^{t} = O_{ik}^{t} \qquad \forall\, i,k$$

$$\sum_{i}\sum_{k} T_{ijk}^{t} = D_{j}^{t} \qquad \forall\, j$$

The result is :

$$T_{ijk}^{t} = T_{ijk}^{p}\, A_{ik}\, B_{j}\, O_{ik}^{t}\, D_{j}^{t}$$

where:

$$A_{ik} = \frac{1}{\sum_j T^p_{ijk} \, B_j \, D_j}$$

$$B_j = \frac{1}{\sum_i \sum_k T^p_{ijk} \, A_{ik} \, O_{ik}}$$

The prior trip matrix $\{T_{ijk}^p\}$ is computed as follows:

a) 2001 forecast :

(i) $T^p_{ijk} \quad = \quad T^{86}_{ijk} \text{ if } \sum_k T^{86}_{ijk} \geq 11 \textit{ samples}$

(ii) for O-D pairs in which $\sum_k T^{86}_{ijk} < 11 \textit{ samples}$:

1. Subtract all the case (i) trips from the relevant cells, row & column totals, etc. to yield a "reduced" '86 trip matrix $\{ T^{86}_{ijk} \}$.

   Define the following terms:

   T^{86}_{ij} = total flow i --> j, reduced matrix

   T^{86}_{ik} = total origins in zone i, gender k, reduced matrix

   T^{86}_{jk} = total destinations in zone j, gender k, reduced matrix

2. Solve the following entropy maximization problem :

$$\max_{\{T^p_{ijk}\}} S = -\sum_i \sum_j \sum_k T^p_{ijk}$$

subject to :

$$\sum_k T^p_{ijk} = T^{86}_{ij} \qquad \forall\ i,j$$

$$\sum_j T^p_{ijk} = T^{86}_{ik} \qquad \forall\ i,k$$

$$\sum_i T^p_{ijk} = T^{86}_{jk} \qquad \forall\ j,k$$

This yields:

$$T^p_{ijk} = A_{ij}\ B_{ik}\ C_{jk}\ T^{86}_{ij}\ T^{86}_{ik}\ T^{86}_{jk}$$

where:

$$A_{ij} = \frac{1}{\sum_k B_{ik}\ C_{jk}\ T^{86}_{ik}\ T^{86}_{jk}}$$

$$B_{ik} = \frac{1}{\sum_j A_{ij}\ C_{jk}\ T^{86}_{ij}\ T^{86}_{jk}}$$

$$C_{jk} = \frac{1}{\sum_i A_{ij}\ B_{ik}\ T^{86}_{ij}\ T^{86}_{ik}}$$

which defines the T^p_{ijk} values for the small sample cells

Note : if zero flow is observed i --> j, T_{ijk} will still be zero.

b) 2011 forecast :

Use the 2001 trip table.

APPENDIX C

MODAL SPLIT TABLES BY GENDER BY TIME-OF-DAY BY MODE

This appendix presents tables of 1986 average work trip modal splits for O-D flows expressed in terms of the 13 "mode split analysis zones" defined in Table 3.3. These mode splits are disaggregated by worker gender and by peak/off-peak trip start times. Three modes are included in the tables: auto, transit, and walk (plus "other").

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MODAL SPLIT FOR MALE, PEAK PERIOD, AUTO TRIPS

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Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.293	0.591	0.529	0.756	1.000	1.000	0.792
2	0.400	0.655	0.757	0.803	1.000	0.886	0.879
3	0.494	0.803	0.815	0.838	1.000	0.935	0.913
4	0.543	0.854	0.888	0.886	1.000	0.947	0.908
5	0.536	0.973	1.000	1.000	0.914	0.956	1.000
6	0.508	0.987	0.968	0.973	0.973	0.934	0.957
7	0.600	0.956	0.946	0.963	1.000	1.000	0.910
8	0.688	0.976	0.979	0.995	1.000	1.000	0.986
9	0.604	0.905	0.925	0.972	1.000	1.000	1.000
10	0.528	0.903	0.985	1.000	1.000	0.000	0.947
11	0.497	0.871	0.930	0.990	1.000	1.000	0.922
12	0.553	0.902	0.959	0.982	0.000	0.549	1.000
13	0.526	0.859	1.000	1.000	0.000	1.000	1.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.789	0.829	0.950	1.000	1.000	1.000
2	0.945	0.908	0.934	1.000	1.000	0.819
3	0.928	0.964	0.972	1.000	1.000	1.000
4	0.961	0.941	0.962	1.000	1.000	1.000
5	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	0.000	1.000
7	0.945	0.983	1.000	1.000	1.000	1.000
8	0.942	1.000	1.000	1.000	1.000	1.000
9	1.000	0.920	0.952	0.983	1.000	1.000
10	1.000	0.967	0.925	1.000	1.000	1.000
11	1.000	1.000	1.000	0.913	0.963	0.974
12	1.000	1.000	1.000	0.967	0.949	1.000
13	1.000	1.000	1.000	0.979	0.996	0.878

MODAL SPLIT FOR MALE, PEAK PERIOD, TRANSIT TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.443	0.374	0.446	0.239	0.000	0.000	0.208
2	0.554	0.227	0.216	0.188	0.000	0.114	0.115
3	0.487	0.178	0.143	0.139	0.000	0.065	0.084
4	0.447	0.124	0.091	0.083	0.000	0.053	0.087
5	0.464	0.014	0.000	0.000	0.023	0.026	0.000
6	0.492	0.013	0.032	0.027	0.003	0.012	0.043
7	0.400	0.044	0.054	0.032	0.000	0.000	0.043
8	0.312	0.024	0.014	0.005	0.000	0.000	0.010
9	0.396	0.095	0.073	0.028	0.000	0.000	0.000
10	0.472	0.097	0.015	0.000	0.000	0.000	0.053
11	0.503	0.129	0.070	0.010	0.000	0.000	0.078
12	0.447	0.098	0.041	0.018	0.000	0.451	0.000
13	0.474	0.141	0.000	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.211	0.171	0.050	0.000	0.000	0.000
2	0.055	0.092	0.066	0.000	0.000	0.181
3	0.062	0.036	0.028	0.000	0.000	0.000
4	0.039	0.059	0.028	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.032	0.017	0.000	0.000	0.000	0.000
8	0.003	0.000	0.000	0.000	0.000	0.000
9	0.000	0.043	0.038	0.017	0.000	0.000
10	0.000	0.025	0.020	0.000	0.000	0.000
11	0.000	0.000	0.000	0.026	0.018	0.026
12	0.000	0.000	0.000	0.008	0.021	0.000
13	0.000	0.000	0.000	0.013	0.004	0.070

MODAL SPLIT FOR MALE, PEAK PERIOD, WALK TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.263	0.035	0.025	0.005	0.000	0.000	0.000
2	0.046	0.118	0.027	0.008	0.000	0.000	0.005
3	0.019	0.019	0.042	0.023	0.000	0.000	0.003
4	0.010	0.022	0.020	0.031	0.000	0.000	0.004
5	0.000	0.013	0.000	0.000	0.064	0.018	0.000
6	0.000	0.000	0.000	0.000	0.024	0.054	0.000
7	0.000	0.000	0.000	0.004	0.000	0.000	0.047
8	0.000	0.000	0.007	0.000	0.000	0.000	0.004
9	0.000	0.000	0.003	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000
3	0.009	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.009	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.023	0.000	0.000	0.000	0.000	0.000
8	0.055	0.000	0.000	0.000	0.000	0.000
9	0.000	0.037	0.010	0.000	0.000	0.000
10	0.000	0.008	0.055	0.000	0.000	0.000
11	0.000	0.000	0.000	0.060	0.018	0.000
12	0.000	0.000	0.000	0.025	0.030	0.000
13	0.000	0.000	0.000	0.008	0.000	0.052

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MODAL SPLIT FOR FEMALE, PEAK PERIOD, AUTO TRIPS
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Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.157	0.383	0.533	0.561	0.756	1.000	0.598
2	0.224	0.376	0.546	0.580	1.000	1.000	0.713
3	0.252	0.588	0.628	0.686	1.000	0.928	0.758
4	0.329	0.691	0.719	0.728	0.936	1.000	0.769
5	0.386	0.841	0.935	0.921	0.846	0.921	1.000
6	0.445	0.958	0.983	0.972	0.925	0.860	1.000
7	0.323	0.812	0.941	0.889	0.707	1.000	0.870
8	0.480	0.851	0.926	0.929	1.000	1.000	0.931
9	0.331	0.792	0.864	0.914	1.000	0.000	0.809
10	0.305	0.946	0.931	0.986	0.000	1.000	0.863
11	0.299	1.000	0.932	0.958	0.000	0.000	0.000
12	0.377	0.626	1.000	0.931	0.000	1.000	0.000
13	0.206	0.384	0.829	0.755	1.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.712	0.681	0.868	0.837	0.000	1.000
2	0.731	0.775	0.879	1.000	0.514	1.000
3	0.786	0.921	0.874	0.881	1.000	0.000
4	0.883	0.941	0.886	1.000	1.000	1.000
5	1.000	1.000	1.000	0.000	0.000	0.000
6	1.000	0.000	0.000	0.000	0.000	0.000
7	0.851	1.000	1.000	1.000	0.000	0.000
8	0.929	1.000	1.000	0.000	0.000	0.000
9	1.000	0.821	0.886	1.000	0.941	0.802
10	1.000	0.945	0.857	0.890	0.854	1.000
11	1.000	0.964	0.978	0.892	0.899	0.983
12	1.000	0.983	0.946	0.913	0.909	0.922
13	0.000	0.902	0.769	0.988	0.985	0.738

MODAL SPLIT FOR FEMALE, PEAK PERIOD, TRANSIT TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION						
	1	2	3	4	5	6	7
1	0.612	0.517	0.428	0.429	0.244	0.000	0.402
2	0.752	0.440	0.416	0.398	0.000	0.000	0.274
3	0.733	0.372	0.287	0.278	0.000	0.072	0.242
4	0.668	0.299	0.246	0.197	0.064	0.000	0.231
5	0.614	0.159	0.065	0.079	0.090	0.051	0.000
6	0.555	0.042	0.017	0.028	0.047	0.019	0.000
7	0.677	0.188	0.059	0.105	0.000	0.000	0.049
8	0.511	0.149	0.074	0.071	0.000	0.000	0.053
9	0.669	0.208	0.136	0.086	0.000	0.000	0.191
10	0.695	0.054	0.069	0.014	0.000	0.000	0.137
11	0.701	0.000	0.068	0.042	0.000	0.000	1.000
12	0.623	0.374	0.000	0.069	0.000	0.000	0.000
13	0.794	0.616	0.171	0.245	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION					
	8	9	10	11	12	13
1	0.288	0.319	0.132	0.163	1.000	0.000
2	0.269	0.225	0.121	0.000	0.486	0.000
3	0.200	0.079	0.126	0.119	0.000	0.000
4	0.117	0.059	0.114	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.075	0.000	0.000	0.000	0.000	1.000
8	0.021	0.000	0.000	0.000	0.000	0.000
9	0.000	0.116	0.095	0.000	0.059	0.198
10	0.000	0.055	0.049	0.110	0.000	0.000
11	0.000	0.036	0.022	0.049	0.058	0.017
12	0.000	0.017	0.054	0.062	0.013	0.078
13	0.000	0.098	0.231	0.012	0.015	0.183

MODAL SPLIT FOR FEMALE, PEAK PERIOD, WALK TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.231	0.099	0.039	0.011	0.000	0.000	0.000
2	0.024	0.184	0.038	0.022	0.000	0.000	0.012
3	0.015	0.039	0.086	0.036	0.000	0.000	0.000
4	0.003	0.010	0.035	0.075	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.064	0.029	0.000
6	0.000	0.000	0.000	0.000	0.029	0.121	0.000
7	0.000	0.000	0.000	0.006	0.293	0.000	0.081
8	0.009	0.000	0.000	0.000	0.000	0.000	0.016
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000
3	0.014	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.073	0.000	0.000	0.000	0.000	0.000
8	0.050	0.000	0.000	0.000	0.000	0.000
9	0.000	0.063	0.019	0.000	0.000	0.000
10	0.000	0.000	0.094	0.000	0.146	0.000
11	0.000	0.000	0.000	0.060	0.044	0.000
12	0.000	0.000	0.000	0.025	0.078	0.000
13	0.000	0.000	0.000	0.000	0.000	0.080

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MODAL SPLIT FOR MALE, OFF-PEAK PERIOD, AUTO TRIPS

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Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION						
	1	2	3	4	5	6	7
1	0.284	0.498	0.488	0.677	0.000	0.000	1.000
2	0.402	0.609	0.707	0.733	0.843	0.834	0.806
3	0.589	0.769	0.738	0.749	0.954	1.000	0.834
4	0.674	0.848	0.813	0.789	1.000	1.000	0.843
5	0.658	1.000	1.000	1.000	0.871	0.945	1.000
6	0.953	1.000	0.950	1.000	0.972	0.857	1.000
7	0.782	0.935	0.975	0.963	1.000	1.000	0.824
8	0.813	1.000	1.000	1.000	1.000	1.000	0.956
9	0.854	0.970	0.960	0.963	1.000	1.000	1.000
10	0.862	0.902	1.000	1.000	1.000	0.000	1.000
11	0.819	1.000	1.000	1.000	0.000	0.000	1.000
12	0.860	1.000	0.639	1.000	1.000	0.000	0.000
13	0.607	0.798	0.827	1.000	0.000	1.000	1.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION					
	8	9	10	11	12	13
1	1.000	0.864	0.874	1.000	1.000	0.000
2	0.873	0.910	0.894	0.923	1.000	1.000
3	0.844	0.975	0.882	0.807	1.000	1.000
4	1.000	0.956	0.965	1.000	1.000	1.000
5	1.000	1.000	1.000	0.000	0.000	0.000
6	1.000	1.000	1.000	0.000	0.000	0.000
7	0.869	1.000	0.761	0.000	1.000	0.000
8	0.933	1.000	1.000	1.000	0.000	0.000
9	1.000	0.900	0.929	0.950	1.000	1.000
10	1.000	0.935	0.897	1.000	1.000	1.000
11	1.000	1.000	0.943	0.900	0.929	0.969
12	1.000	1.000	1.000	0.919	0.922	1.000
13	1.000	1.000	1.000	0.930	0.962	0.815

MODAL SPLIT FOR MALE, OFF-PEAK PERIOD, TRANSIT TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.345	0.367	0.489	0.287	0.000	0.000	0.000
2	0.523	0.212	0.256	0.249	0.157	0.166	0.194
3	0.382	0.202	0.172	0.207	0.000	0.000	0.140
4	0.310	0.127	0.165	0.130	0.000	0.000	0.157
5	0.342	0.000	0.000	0.000	0.038	0.031	0.000
6	0.047	0.000	0.050	0.000	0.007	0.000	0.000
7	0.218	0.065	0.025	0.037	0.000	0.000	0.060
8	0.187	0.000	0.000	0.000	0.000	0.000	0.000
9	0.146	0.030	0.040	0.037	0.000	0.000	0.000
10	0.138	0.098	0.000	0.000	0.000	0.000	0.000
11	0.181	0.000	0.000	0.000	0.000	0.000	0.000
12	0.140	0.000	0.361	0.000	0.000	0.000	0.000
13	0.393	0.202	0.173	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.000	0.136	0.126	0.000	0.000	1.000
2	0.127	0.090	0.106	0.077	0.000	0.000
3	0.156	0.025	0.118	0.000	0.000	0.000
4	0.000	0.044	0.035	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.019	0.000	0.239	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.040	0.058	0.050	0.000	0.000
10	0.000	0.049	0.039	0.000	0.000	0.000
11	0.000	0.000	0.000	0.022	0.012	0.031
12	0.000	0.000	0.000	0.026	0.000	0.000
13	0.000	0.000	0.000	0.070	0.038	0.103

MODAL SPLIT FOR MALE, OFF-PEAK PERIOD, WALK TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION						
	1	2	3	4	5	6	7
1	0.371	0.135	0.024	0.037	0.000	0.000	0.000
2	0.075	0.179	0.037	0.018	0.000	0.000	0.000
3	0.029	0.029	0.090	0.044	0.046	0.000	0.025
4	0.015	0.025	0.022	0.080	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.091	0.024	0.000
6	0.000	0.000	0.000	0.000	0.021	0.143	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.116
8	0.000	0.000	0.000	0.000	0.000	0.000	0.044
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION					
	8	9	10	11	12	13
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.193	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.112	0.000	0.000	0.000	0.000	0.000
8	0.067	0.000	0.000	0.000	0.000	0.000
9	0.000	0.061	0.014	0.000	0.000	0.000
10	0.000	0.015	0.064	0.000	0.000	0.000
11	0.000	0.000	0.057	0.079	0.059	0.000
12	0.000	0.000	0.000	0.054	0.078	0.000
13	0.000	0.000	0.000	0.000	0.000	0.082

MODAL SPLIT FOR FEMALE, OFF-PEAK PERIOD, AUTO TRIPS

Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION						
	1	2	3	4	5	6	7
1	0.159	0.342	0.471	0.355	1.000	0.000	0.836
2	0.281	0.361	0.524	0.528	1.000	0.000	0.544
3	0.341	0.528	0.547	0.667	0.669	1.000	0.682
4	0.442	0.614	0.687	0.705	1.000	0.000	0.837
5	0.713	1.000	0.912	1.000	0.777	0.884	1.000
6	1.000	1.000	1.000	0.867	0.927	0.761	1.000
7	0.590	0.951	0.860	0.767	1.000	0.000	0.735
8	0.700	1.000	0.831	0.920	0.000	1.000	0.923
9	0.721	0.778	0.871	0.890	0.000	0.000	1.000
10	0.666	1.000	0.896	0.912	1.000	0.000	1.000
11	0.616	1.000	1.000	1.000	0.000	0.000	0.000
12	0.731	1.000	1.000	1.000	1.000	0.000	1.000
13	0.707	1.000	0.000	0.745	0.000	1.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION					
	8	9	10	11	12	13
1	0.540	1.000	1.000	0.000	1.000	0.000
2	0.702	0.763	0.566	0.000	0.000	0.000
3	0.908	0.791	0.868	0.000	1.000	1.000
4	0.634	0.944	1.000	0.000	1.000	1.000
5	0.000	1.000	0.000	0.000	0.000	0.000
6	0.000	1.000	0.000	0.000	0.000	0.000
7	0.948	1.000	1.000	0.000	0.000	0.000
8	0.843	1.000	1.000	0.000	0.000	0.000
9	1.000	0.695	0.853	0.930	1.000	1.000
10	1.000	0.920	0.839	0.796	1.000	1.000
11	0.000	0.928	0.863	0.725	0.816	1.000
12	1.000	1.000	1.000	0.923	0.947	1.000
13	1.000	1.000	1.000	0.859	0.904	0.632

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MODAL SPLIT FOR FEMALE, OFF-PEAK PERIOD, TRANSIT TRIPS
==
Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.499	0.505	0.461	0.606	0.000	0.000	0.164
2	0.643	0.382	0.355	0.433	0.000	0.000	0.456
3	0.637	0.393	0.311	0.289	0.000	0.000	0.274
4	0.524	0.348	0.265	0.184	0.000	0.000	0.163
5	0.287	0.000	0.088	0.000	0.093	0.046	0.000
6	0.000	0.000	0.000	0.133	0.054	0.000	0.000
7	0.381	0.049	0.119	0.233	0.000	0.000	0.125
8	0.300	0.000	0.169	0.080	0.000	0.000	0.041
9	0.279	0.222	0.129	0.110	0.000	0.000	0.000
10	0.334	0.000	0.104	0.088	0.000	0.000	0.000
11	0.384	0.000	0.000	0.000	0.000	0.000	0.000
12	0.269	0.000	0.000	0.000	0.000	0.000	0.000
13	0.293	0.000	0.000	0.255	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.460	0.000	0.000	0.000	0.000	0.000
2	0.298	0.237	0.434	0.000	0.000	0.000
3	0.092	0.209	0.132	1.000	0.000	0.000
4	0.366	0.056	0.000	1.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.034	0.000	0.000	0.000	0.000	0.000
8	0.014	0.000	0.000	0.000	0.000	0.000
9	0.000	0.139	0.082	0.070	0.000	0.000
10	0.000	0.080	0.000	0.204	0.000	0.000
11	0.000	0.000	0.137	0.094	0.038	0.000
12	0.000	0.000	0.000	0.055	0.028	0.000
13	0.000	0.000	0.000	0.141	0.096	0.195

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MODAL SPLIT FOR FEMALE, OFF-PEAK PERIOD, WALK TRIPS
==
Presented as O-D Flow Matrix Form

Modal Split ORIGIN	Modal Split Zones : DESTINATION 1	2	3	4	5	6	7
1	0.342	0.153	0.068	0.040	0.000	0.000	0.000
2	0.076	0.258	0.121	0.039	0.000	0.000	0.000
3	0.022	0.079	0.142	0.044	0.331	0.000	0.045
4	0.034	0.038	0.048	0.111	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.130	0.070	0.000
6	0.000	0.000	0.000	0.000	0.020	0.239	0.000
7	0.029	0.000	0.021	0.000	0.000	0.000	0.140
8	0.000	0.000	0.000	0.000	0.000	0.000	0.037
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Modal Split ORIGIN	Modal Split Zones : DESTINATION 8	9	10	11	12	13
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000
7	0.017	0.000	0.000	0.000	0.000	0.000
8	0.142	0.000	0.000	0.000	0.000	0.000
9	0.000	0.166	0.065	0.000	0.000	0.000
10	0.000	0.000	0.161	0.000	0.000	0.000
11	0.000	0.072	0.000	0.181	0.146	0.000
12	0.000	0.000	0.000	0.023	0.024	0.000
13	0.000	0.000	0.000	0.000	0.000	0.173

APPENDIX D

O-D MODE SPLIT SYNTHESIS PROCEDURE

The work trip modal splits presented in Appendix C are expressed in terms of the specially constructed 13 zone system discussed in Chapter 3. The work trip O-D flows generated by the trip distribution model described in Appendix B, however, are expressed in terms of the 46 zone system. In general, a given O-D pair within the 46 zone system will contain several different O-D pairs expressed in the mode split 13 zone system, with varying numbers of trips per 13 zone pairing. Thus, a procedure is required to synthesize modal split on a 46 zone O-D basis from the 13 zone data.

Define the following variables:

T_{ijk}	=	work trip flow from zone i to zone j for workers of sex k; i and j expressed in terms of the 46 zone system (generated by the work trip distribution model, see Appendix B)
f_{yzm}	=	fraction of trips travelling from "mode split analysis zone" y to "mode split analysis zone" z by mode m (from Appendix C)
$O_{y\|i}$	=	Number of workers resident in mode split analysis zone y within residence zone i (known from density class, demographic and labour force participation models, see Chapter 3 and Appendix G)
$D_{z\|j}$	=	Number of jobs located in mode split analysis zone z within employment zone j (known from scenario inputs and the density class model, see Chapter 3)
$T_{yzk\|ij}$	=	work trip flow from mode split analysis zone y to mode split analysis zone z for workers of sex k living in residence zone i and working in employment zone j

The $T_{yzk|ij}$ are unknown. They must, however, satisfy the constraint:

$$\sum_{z} \sum_{y} T_{yzk|ij} = T_{ijk} \qquad [D.1]$$

If one assumes that $T_{yzk|ij}$ is proportional to both $O_{y|i}$ and $D_{z|j}$, then the least-biased estimate of this term is given by:

$$T_{yzk|ij} = \{ O_{y|i} / \Sigma_y O_{y|i} \}\{ D_{z|j} / \Sigma_z D_{z|j} \} T_{ijk} \qquad [D.2]$$

and the required number of trips made by mode m from zone i to zone j by workers of gender k, M_{ijkm} is then given by:

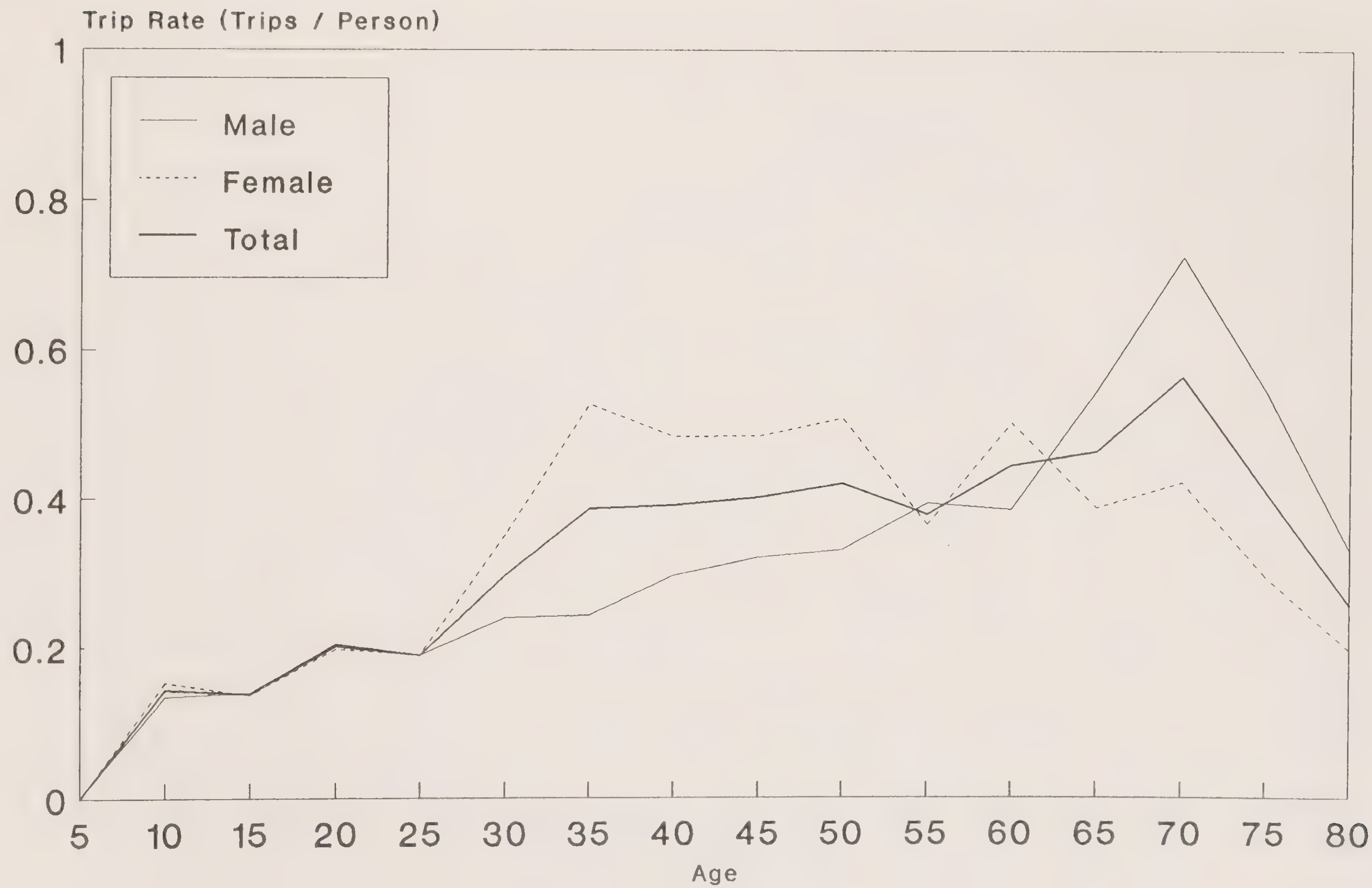
$$M_{ijkm} = \Sigma_y \Sigma_z T_{yzk} f_{ij} f_{yzm} \qquad [D.3]$$

APPENDIX E

NON-WORK HOME-BASED TRIP RATES BY AGE BY GENDER BY DENSITY CLASS BY MODE

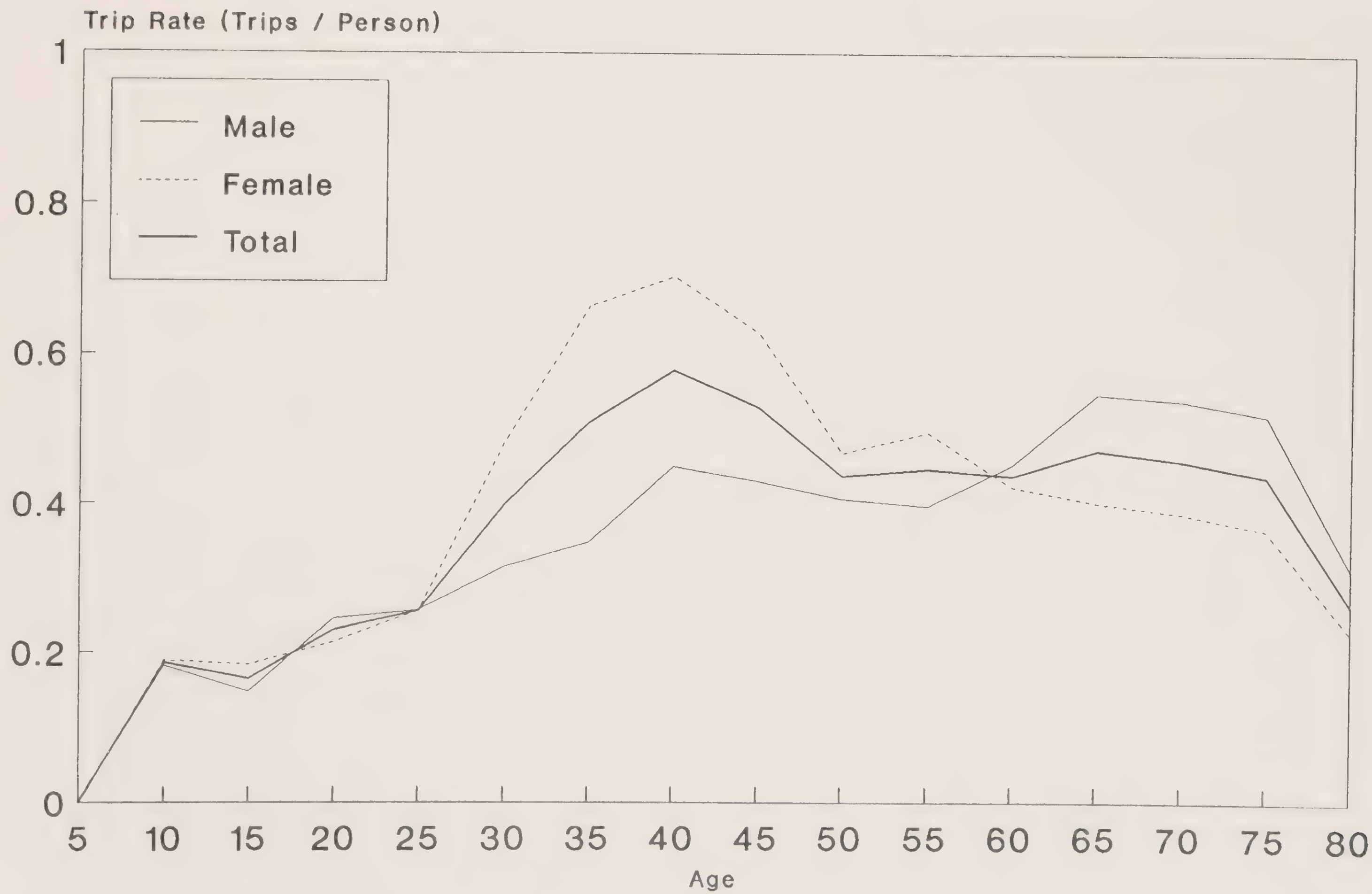
This appendix presents plots of trip rates per person for two modes (auto, transit) for each of two non-work trip purposes (school, other), for each zonal density class. These trip rates are disaggregated by gender (male, female, total) and age group (five-year groupings are used, the average trip rate for each group is plotted at the value of the upper bound of each age group). Note that no attempt has been made to control for small numbers of observations in some age-sex categories (notably age groups over 65 years), with exception of transit other-purpose trip rates for density classes 1 and 2. There are so few observations of this trip type for these two density classes that the trip rates are effectively zero and no plots are produced for these two cases.

Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 1

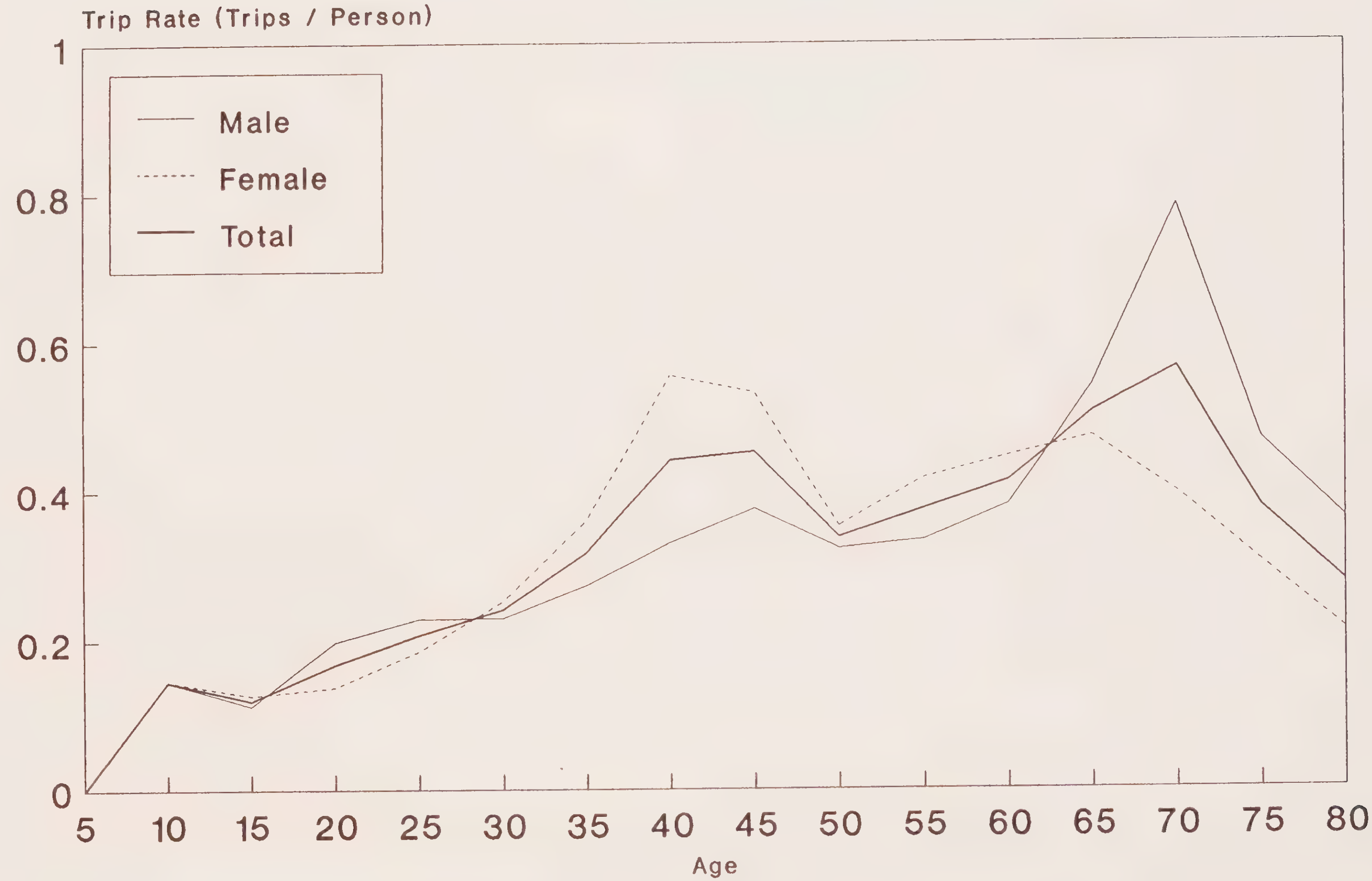


Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 2

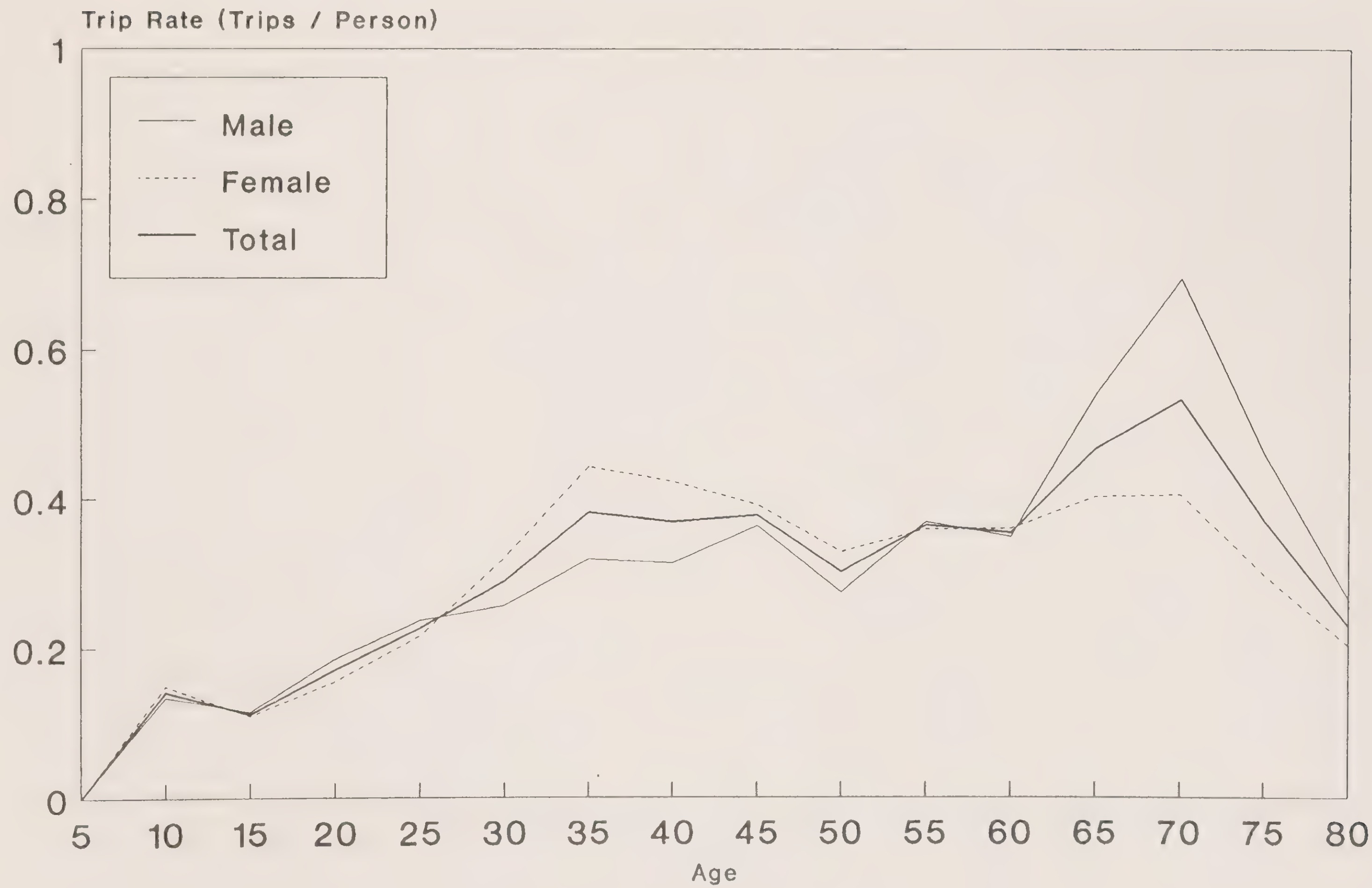
Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 3



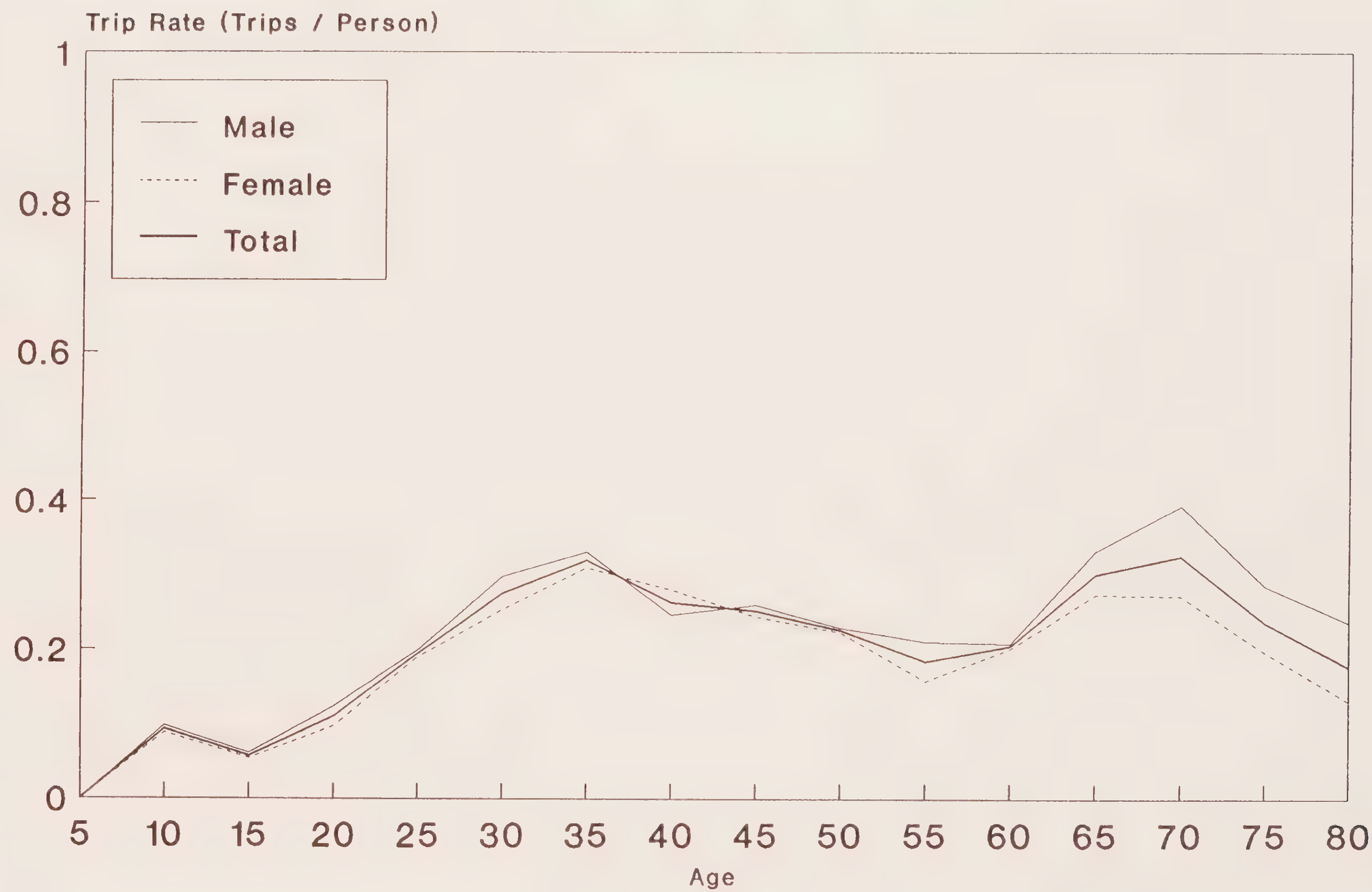
Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 3 (Metro)



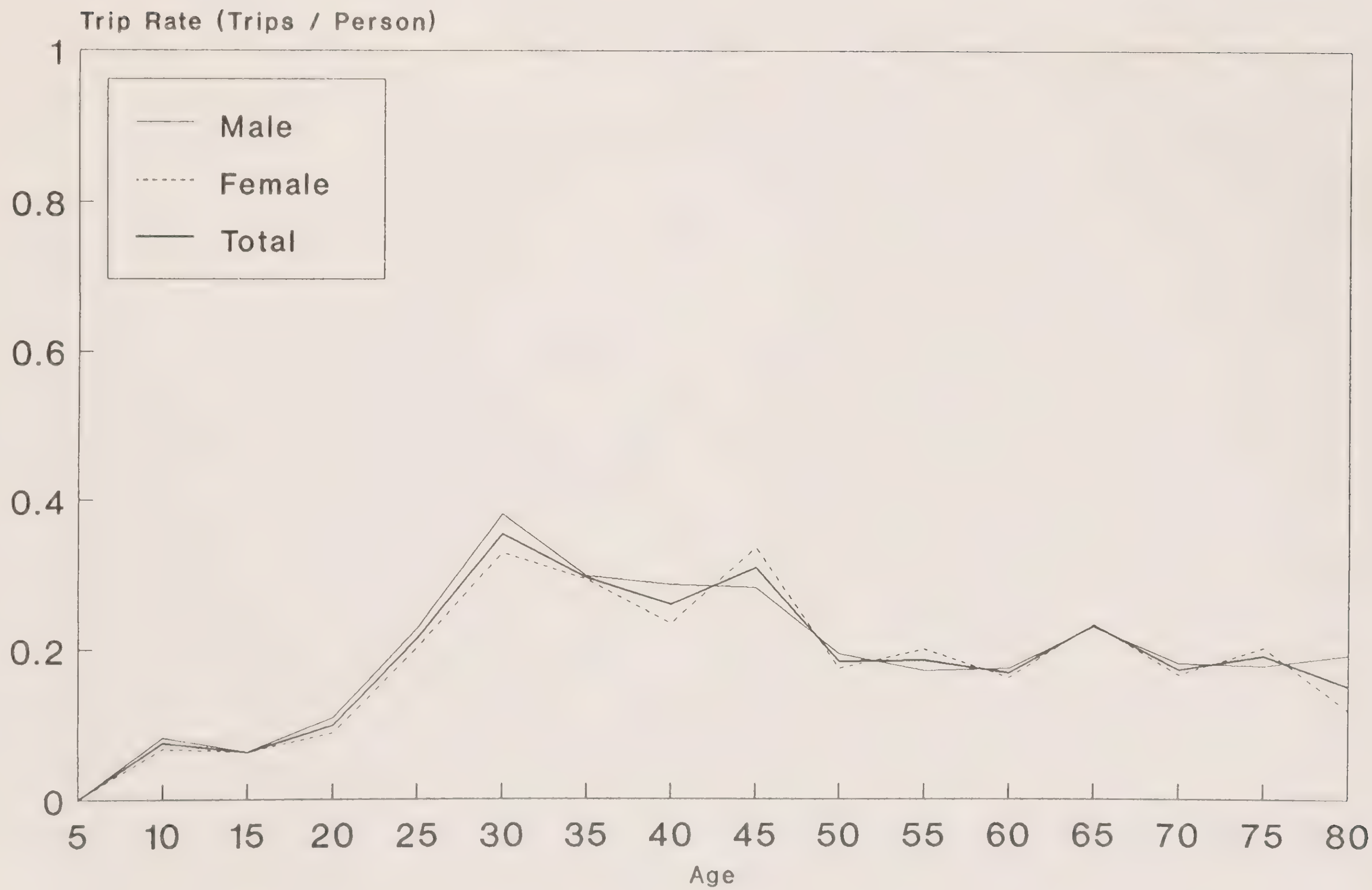
Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 4



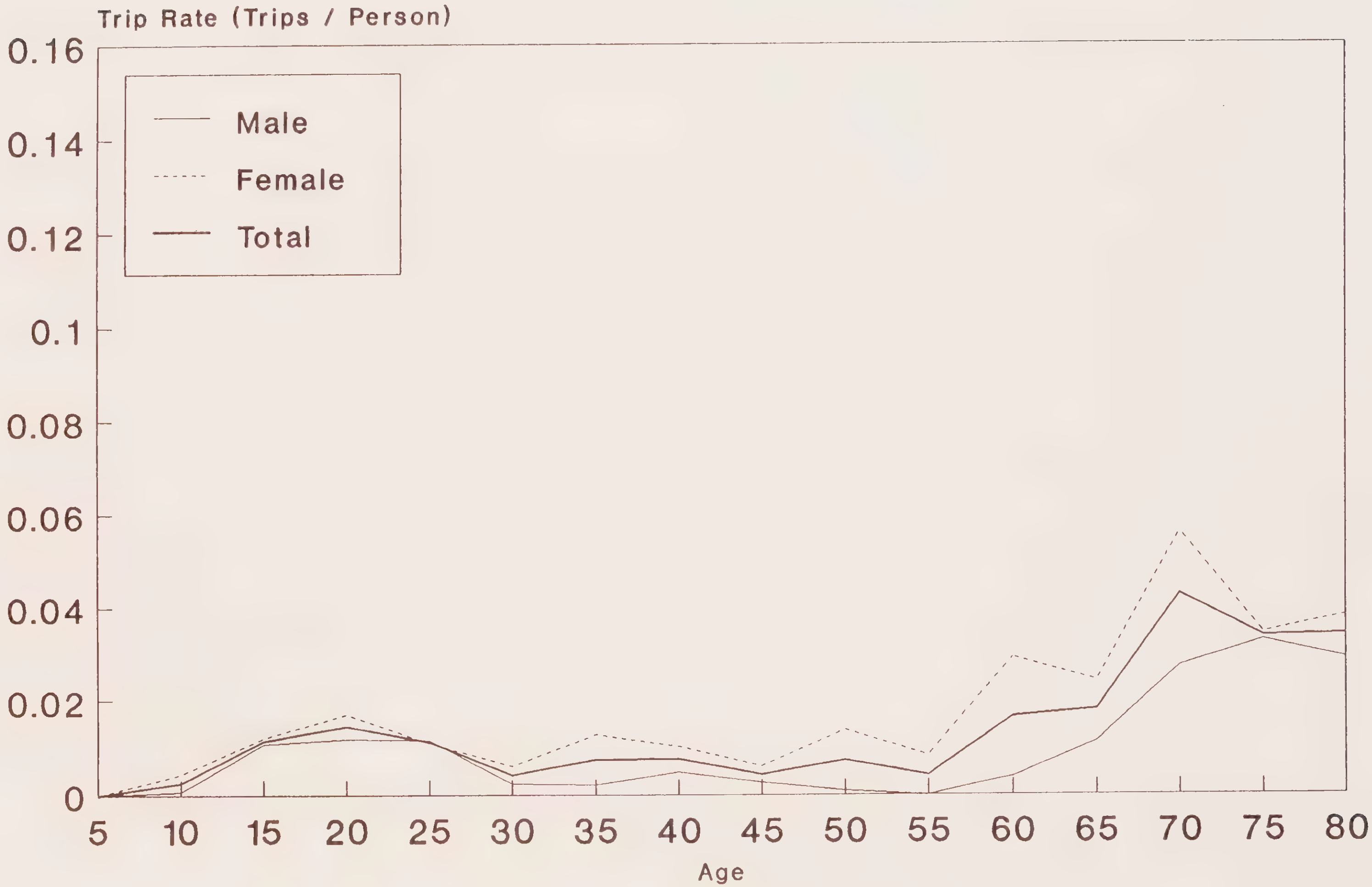
Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 5



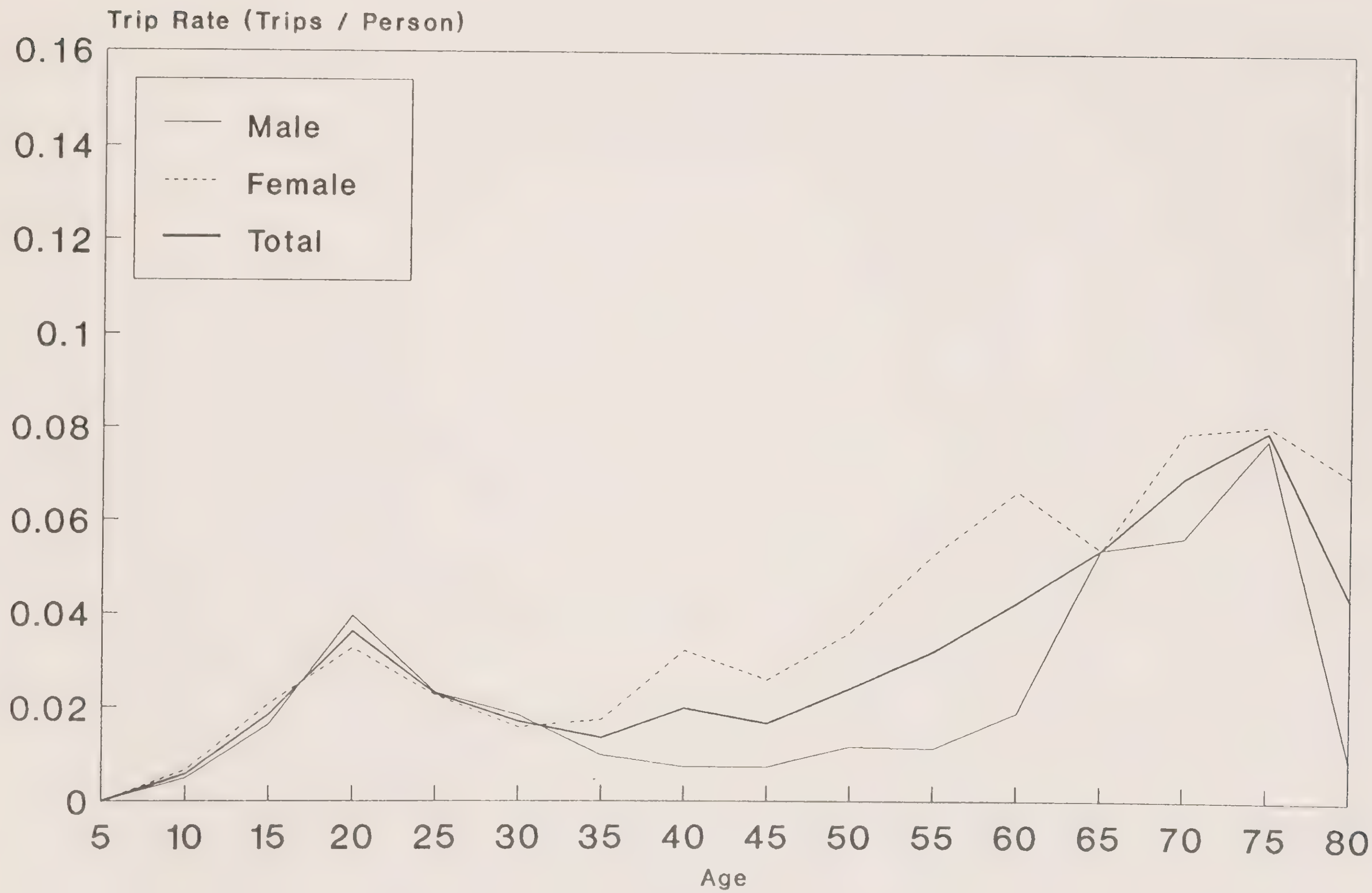
Home-Based Trip Chain Productions
Auto Mode, Other-Purpose Trips
Density Class 6



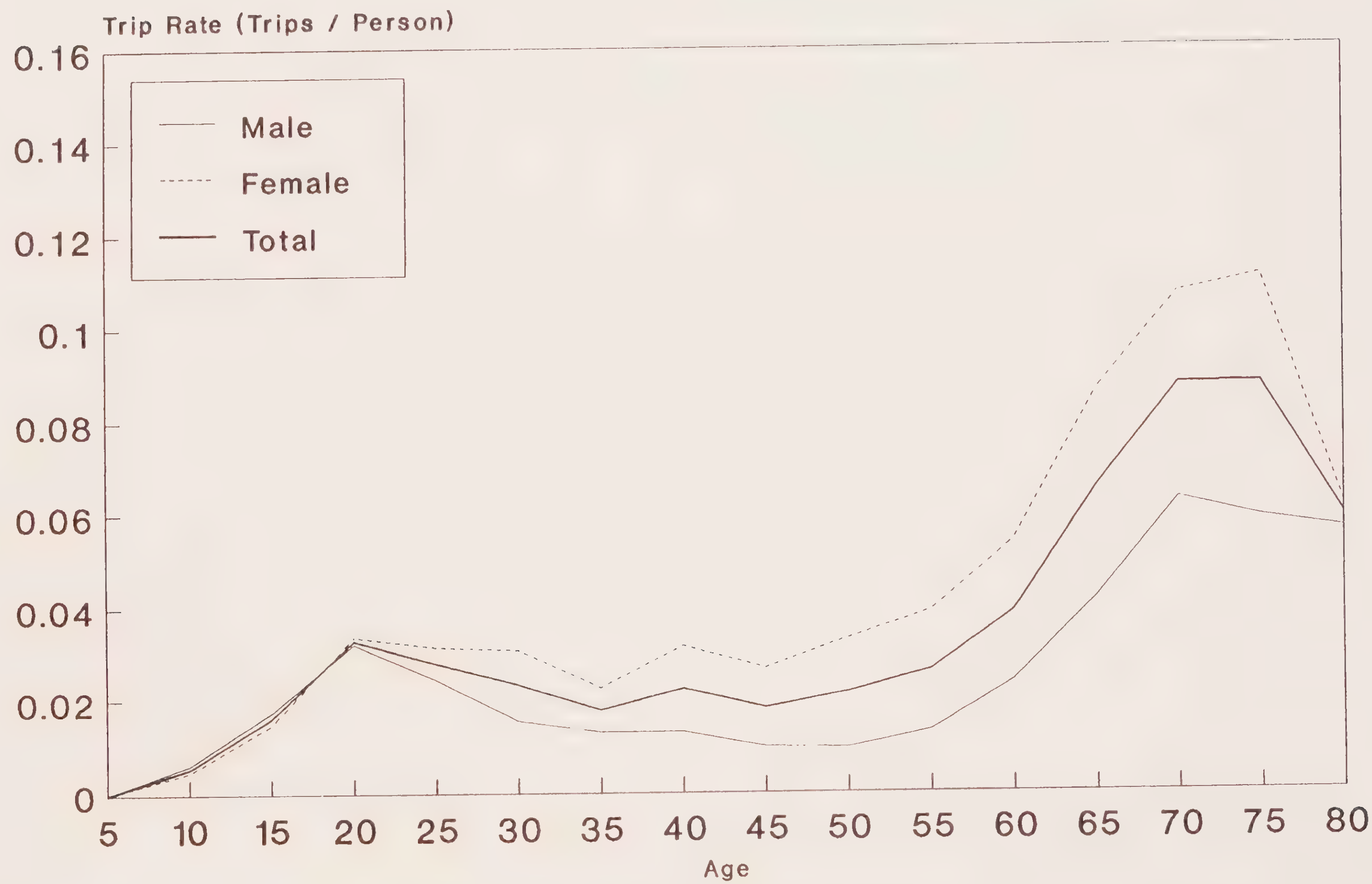
Home-Based Trip Chain Productions
Transit Mode, Other-Purpose Trips
Density Class 3



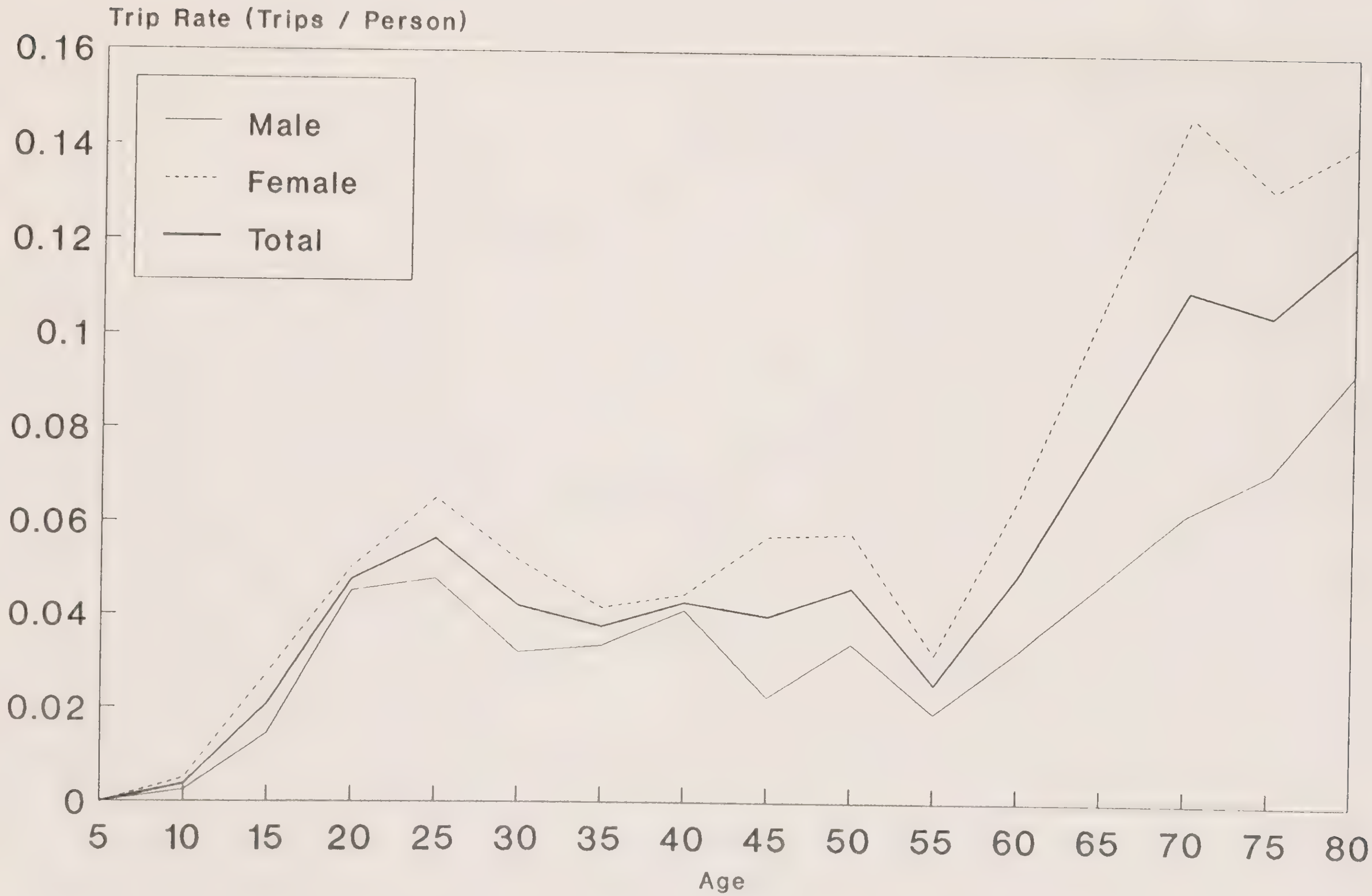
Home-Based Trip Chain Productions
Transit Mode, Other-Purpose Trips
Density Class 3 (Metro)



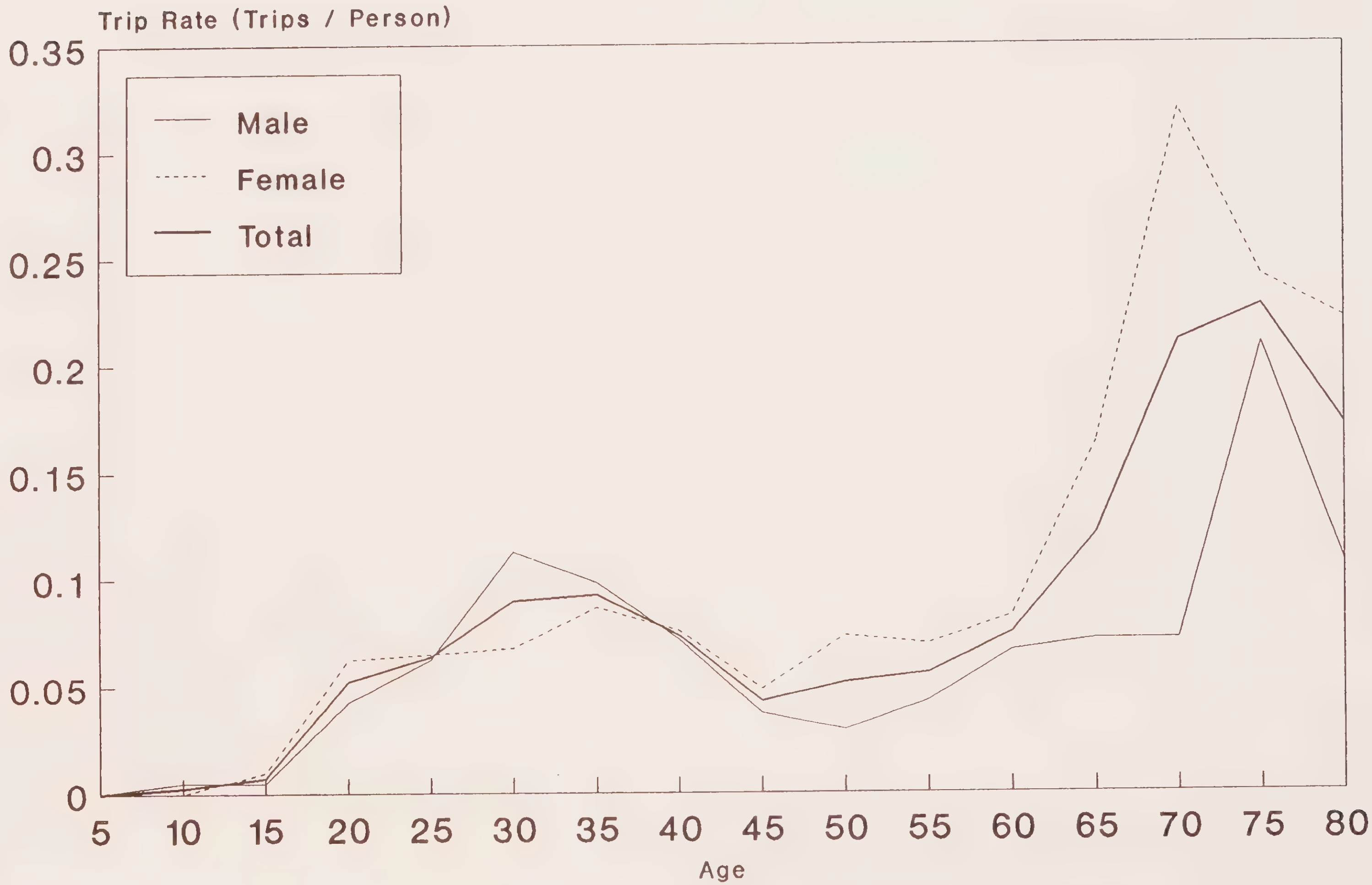
Home-Based Trip Chain Productions
Transit Mode, Other-Purpose Trips
Density Class 4



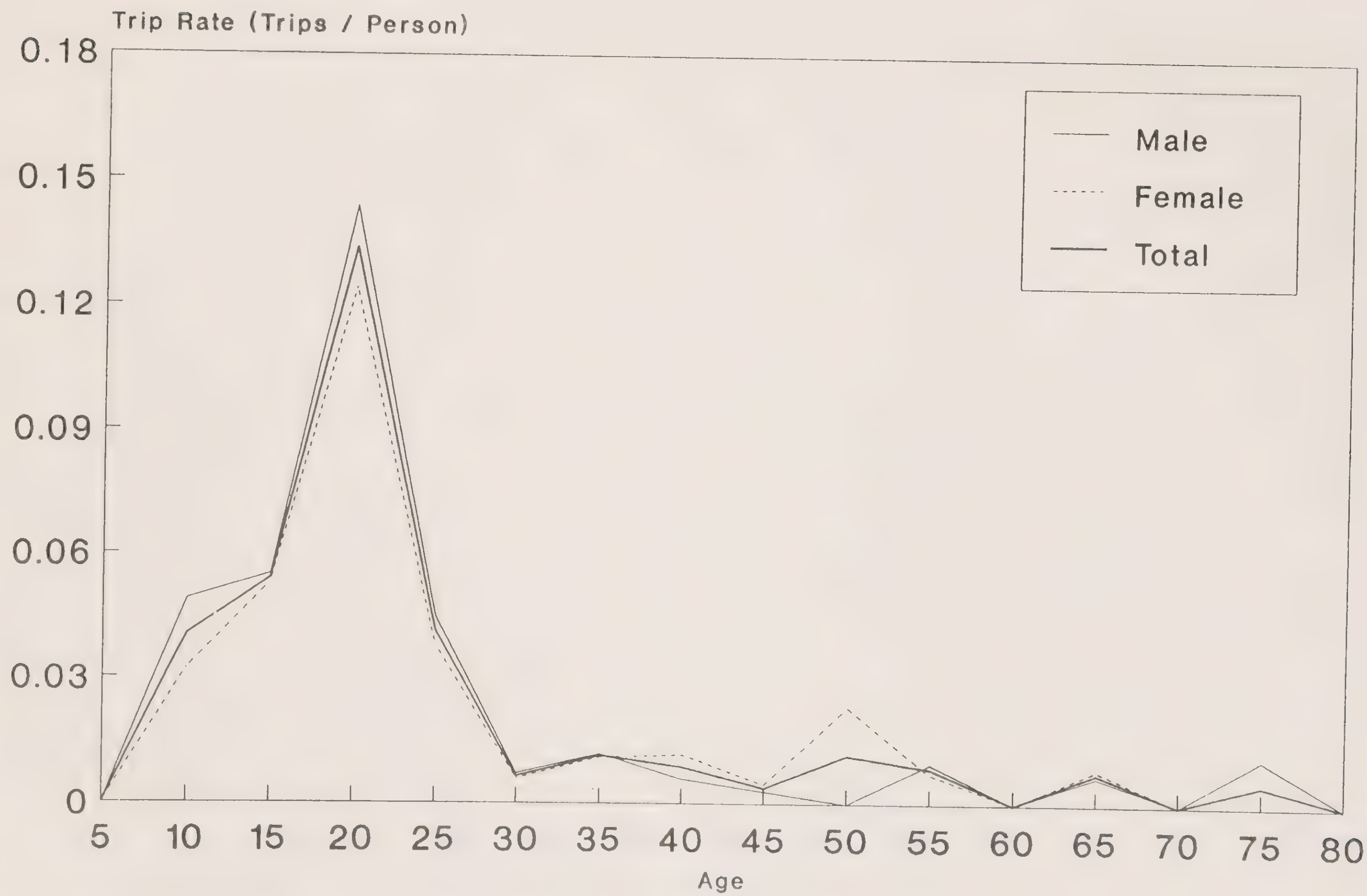
Home-Based Trip Chain Productions
Transit Mode, Other-Purpose Trips
Density Class 5



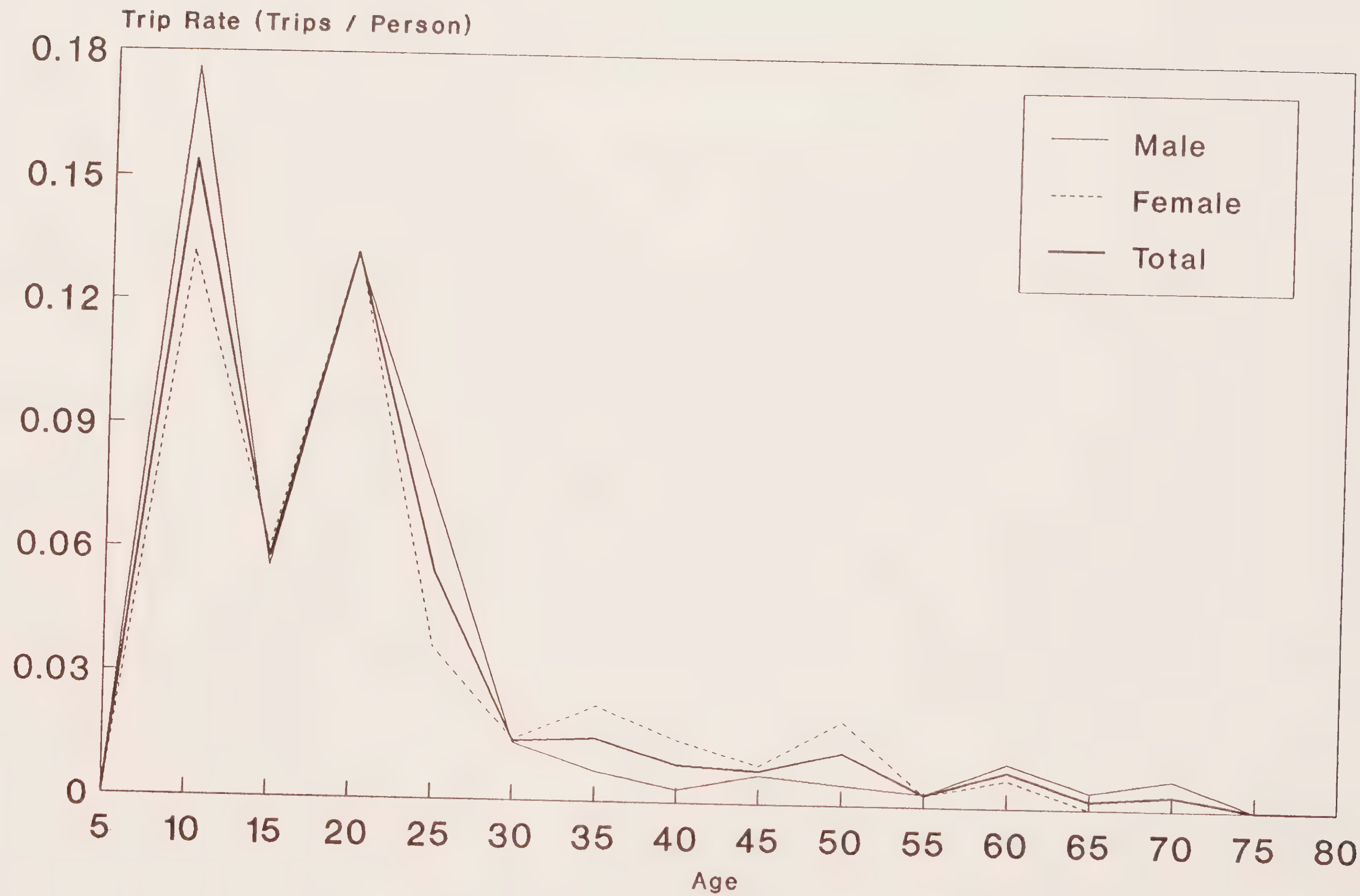
Home-Based Trip Chain Productions
Transit Mode, Other-Purpose Trips
Density Class 6



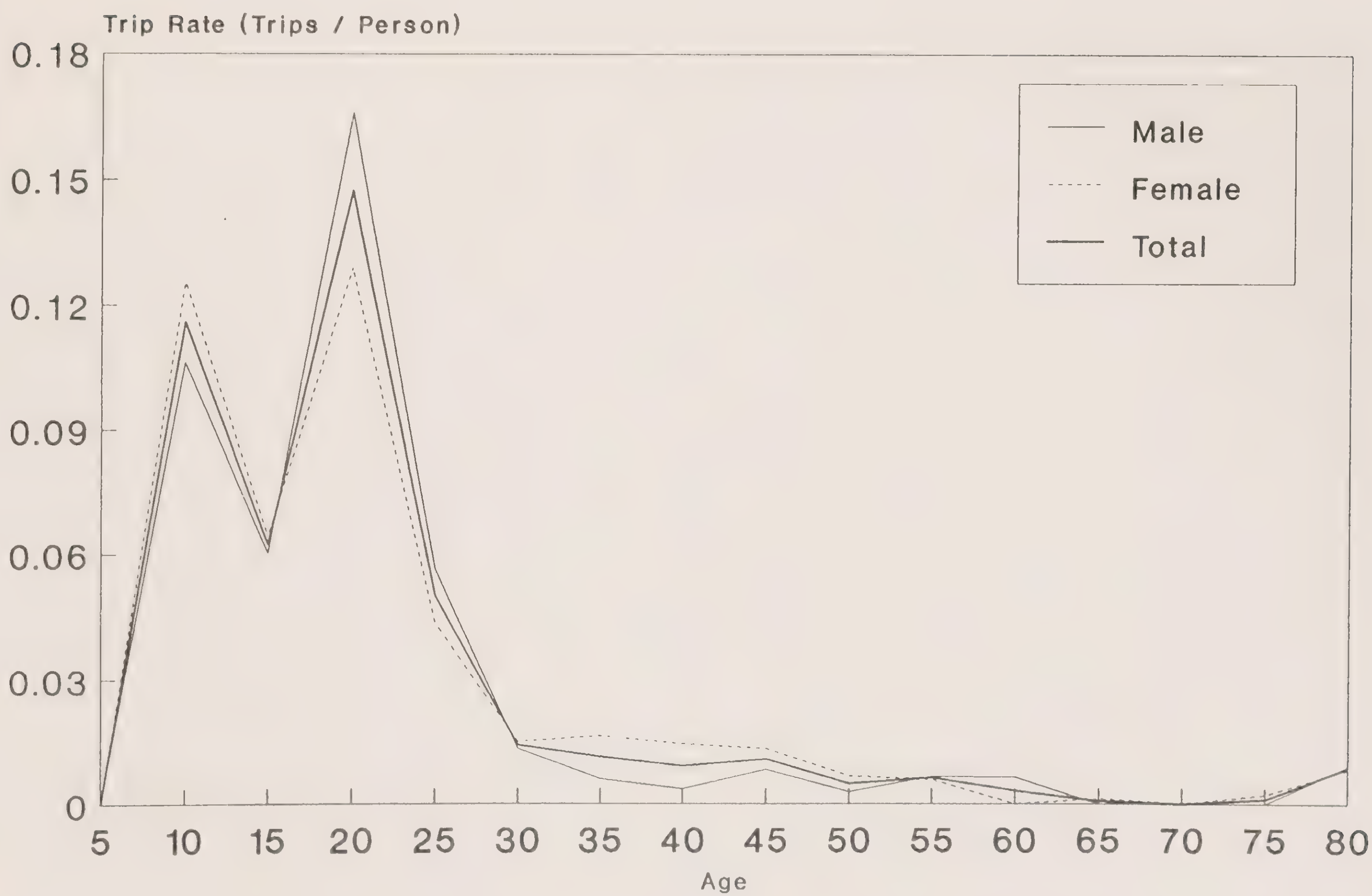
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 1



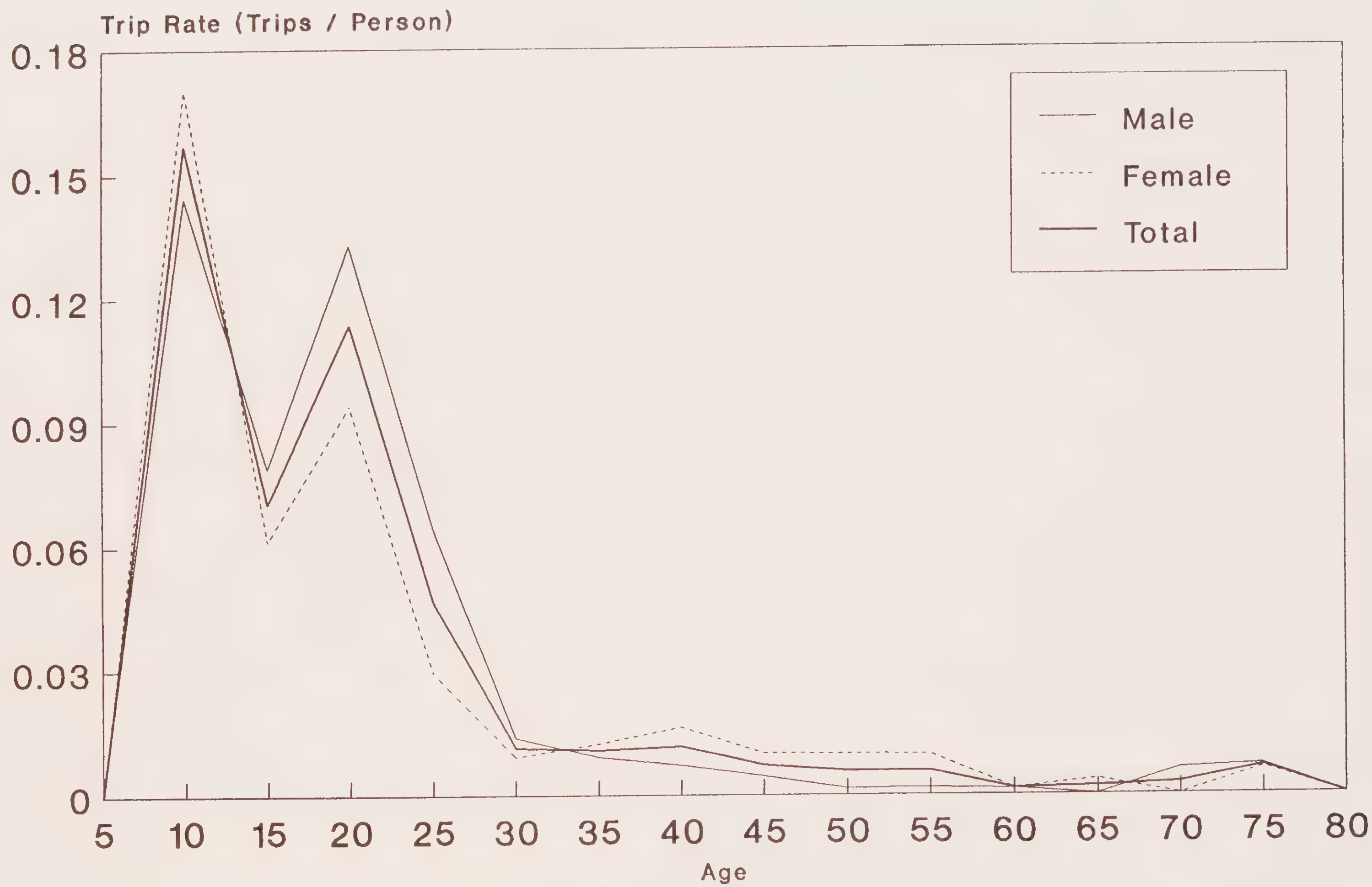
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 2



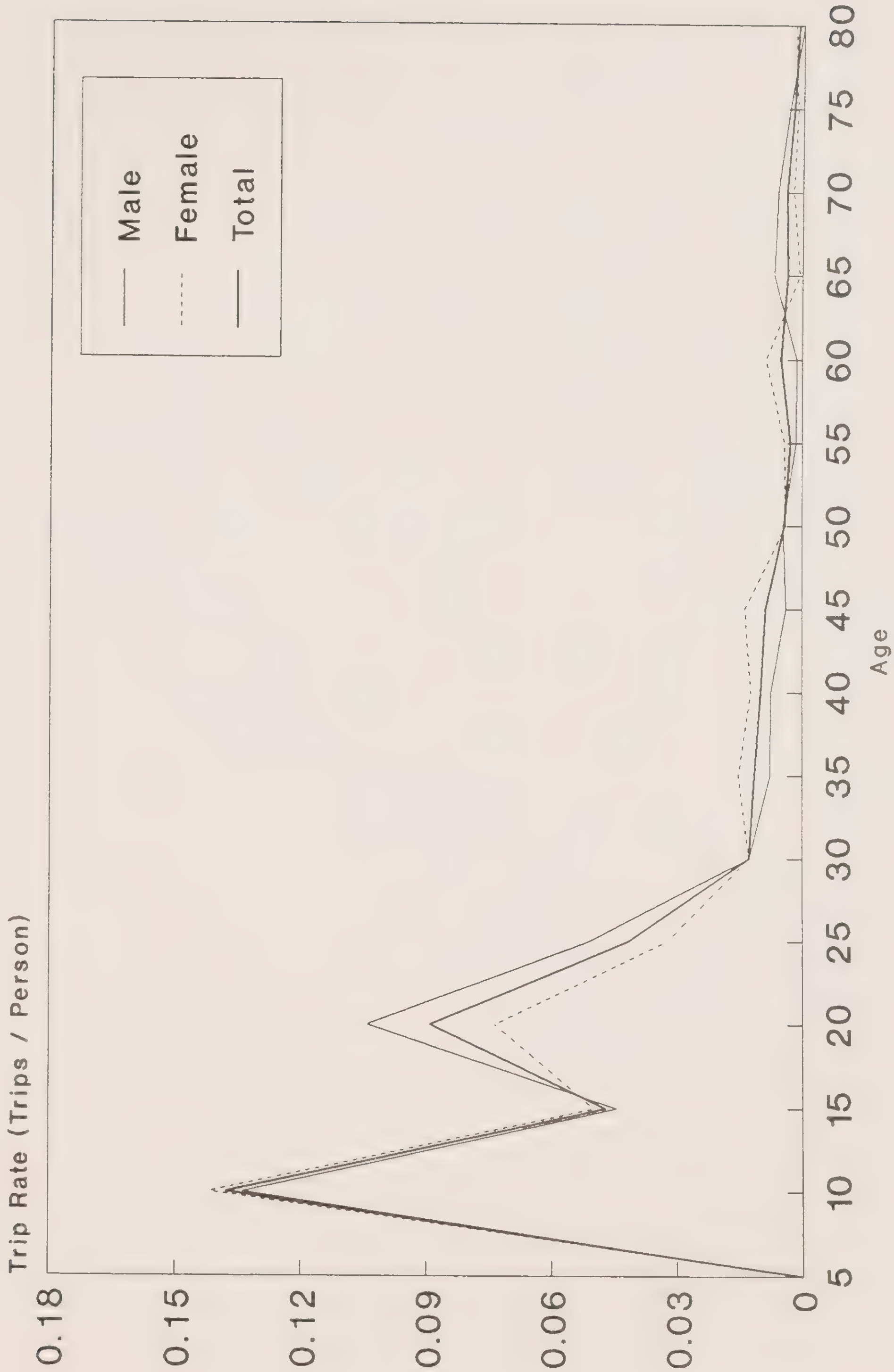
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 3



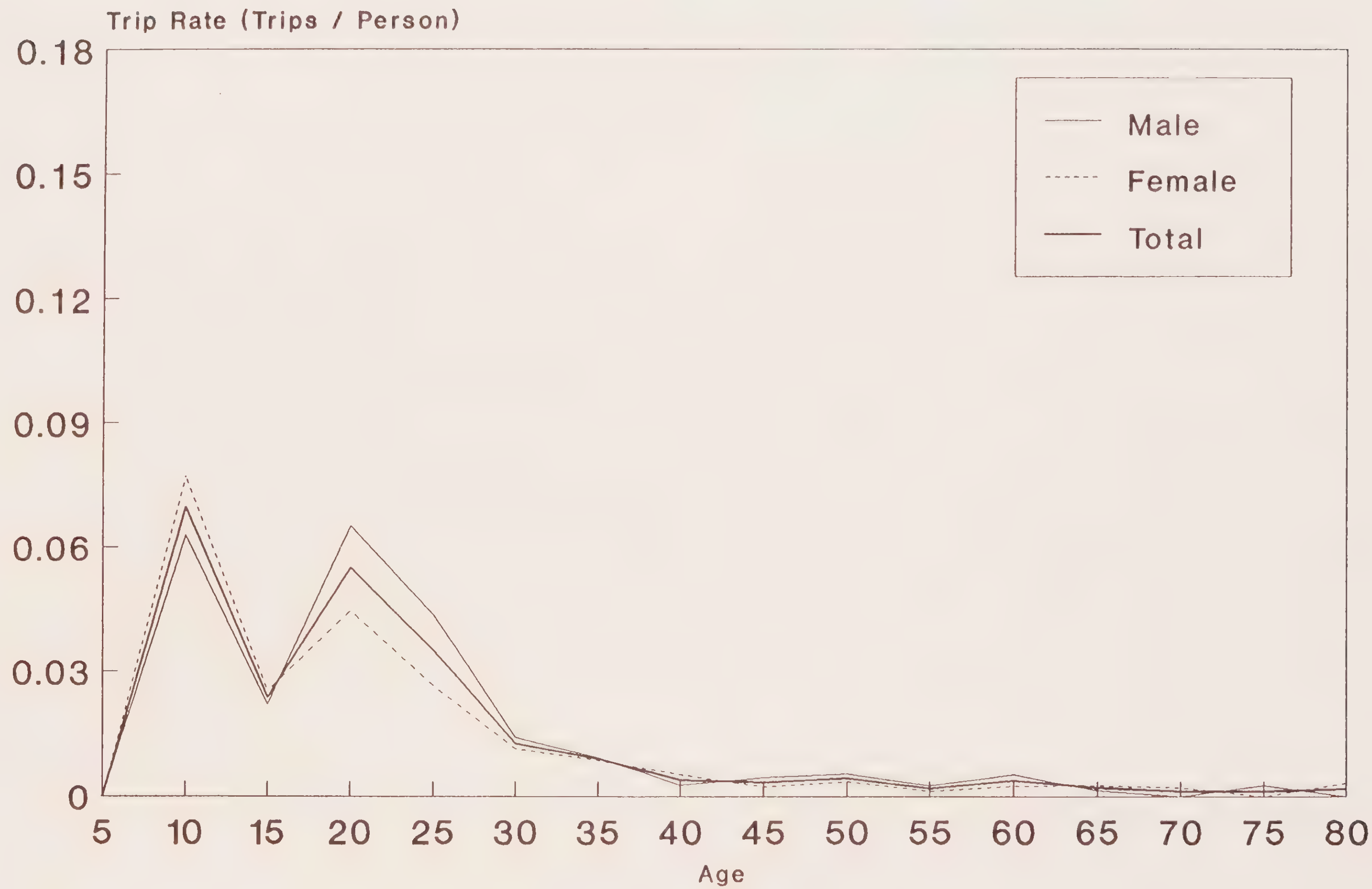
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 3 (Metro)



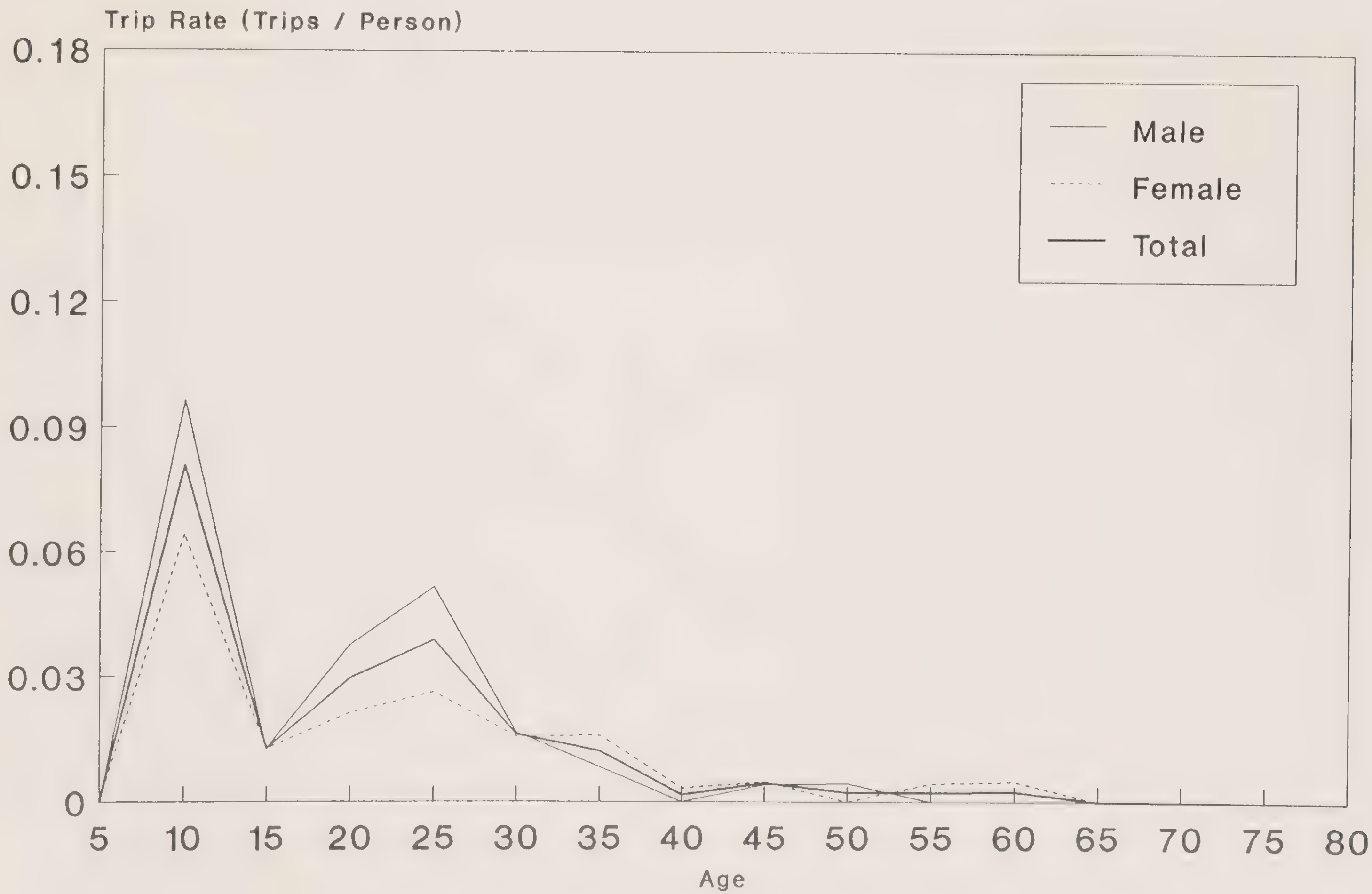
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 4



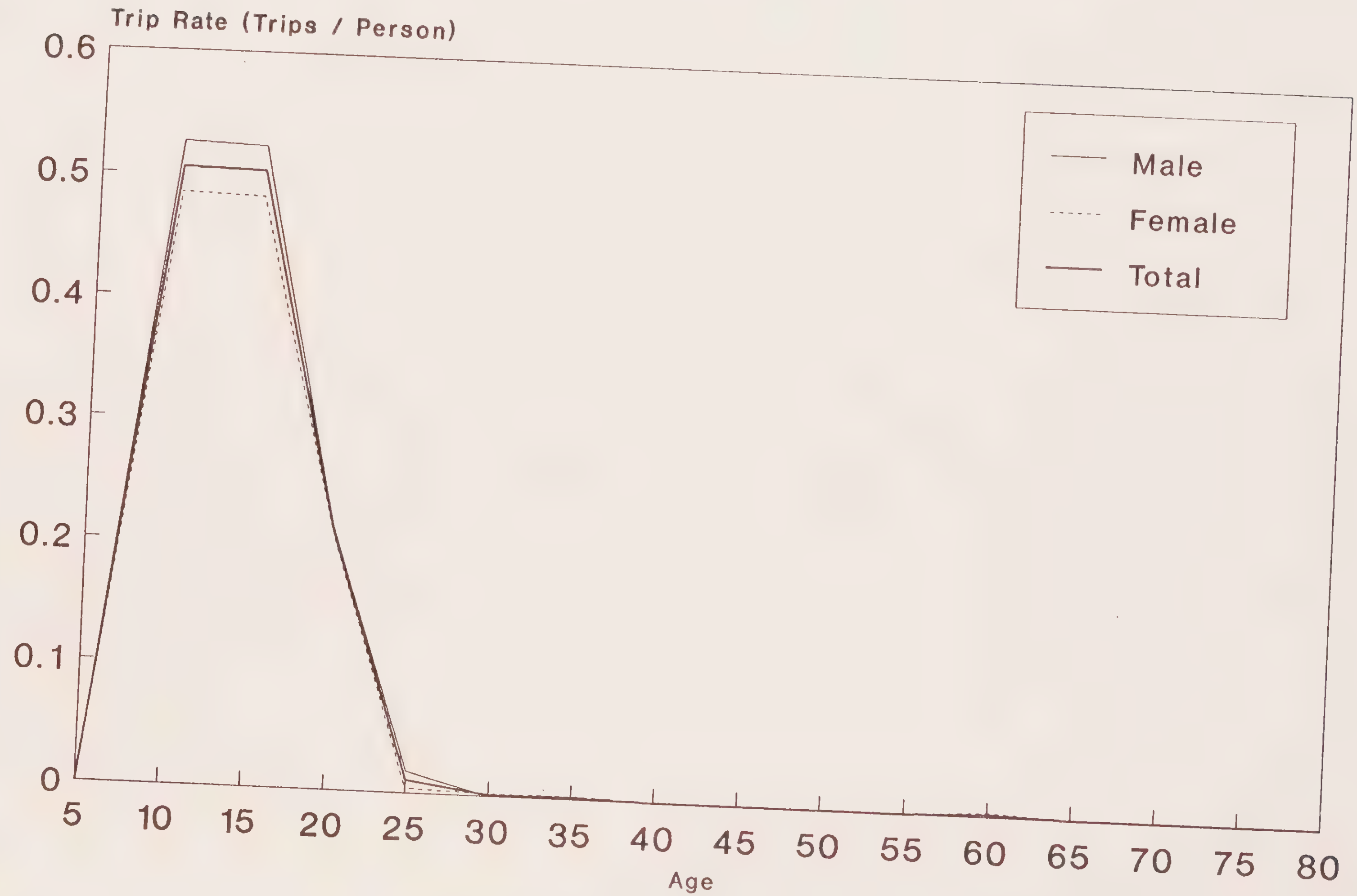
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 5



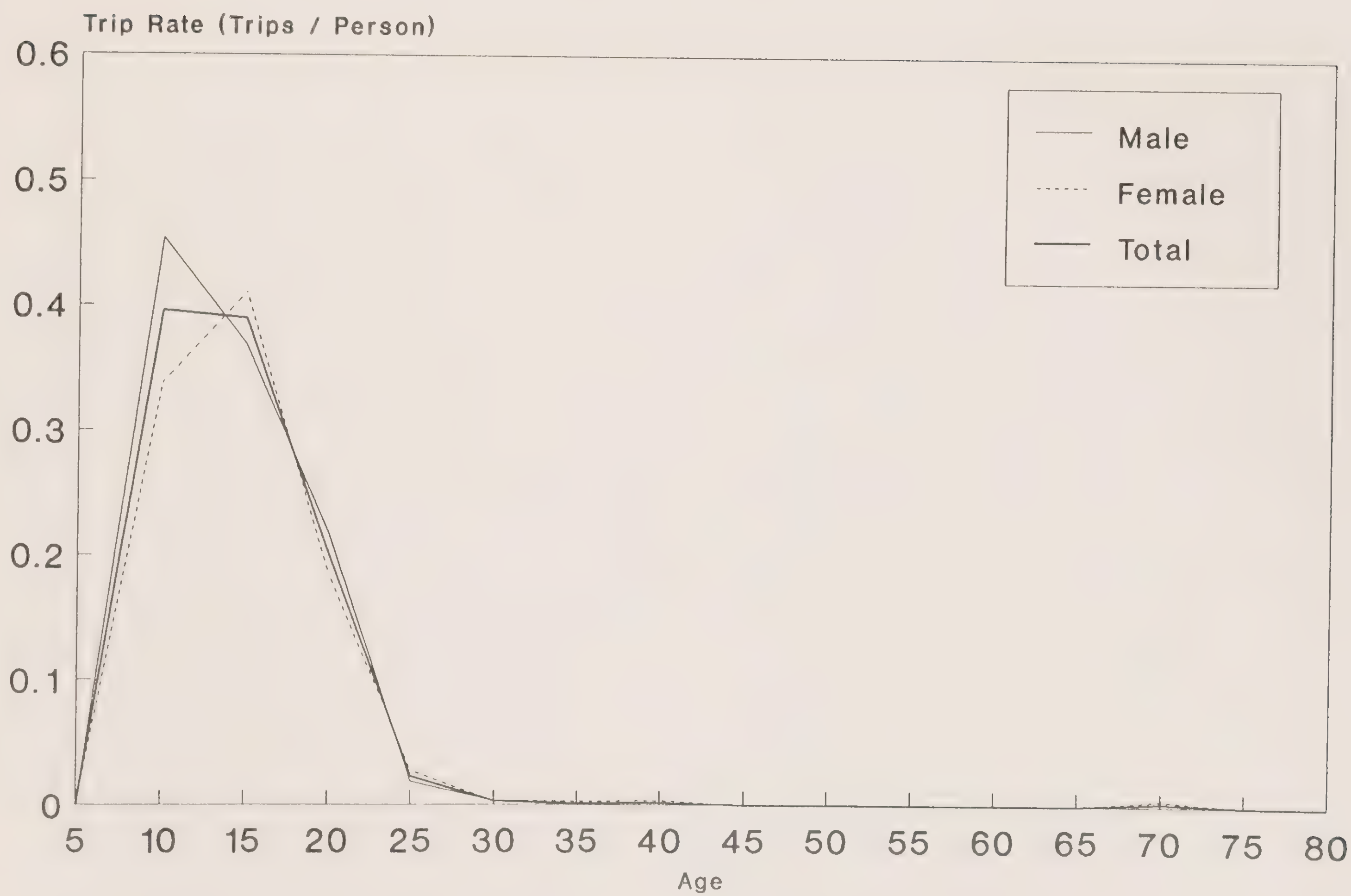
Home-Based Trip Chain Productions
Auto Mode, School Trips
Density Class 6



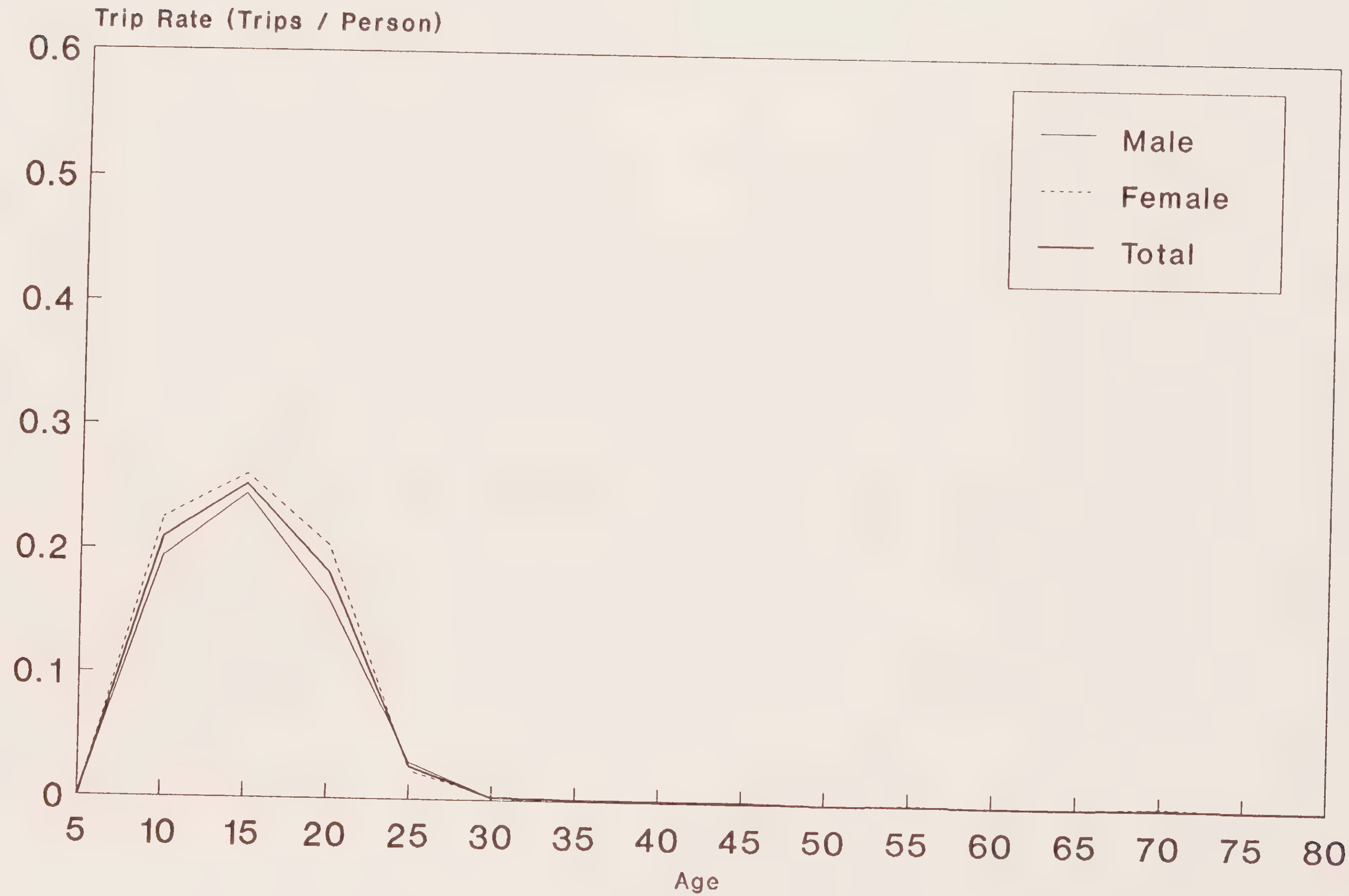
Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 1



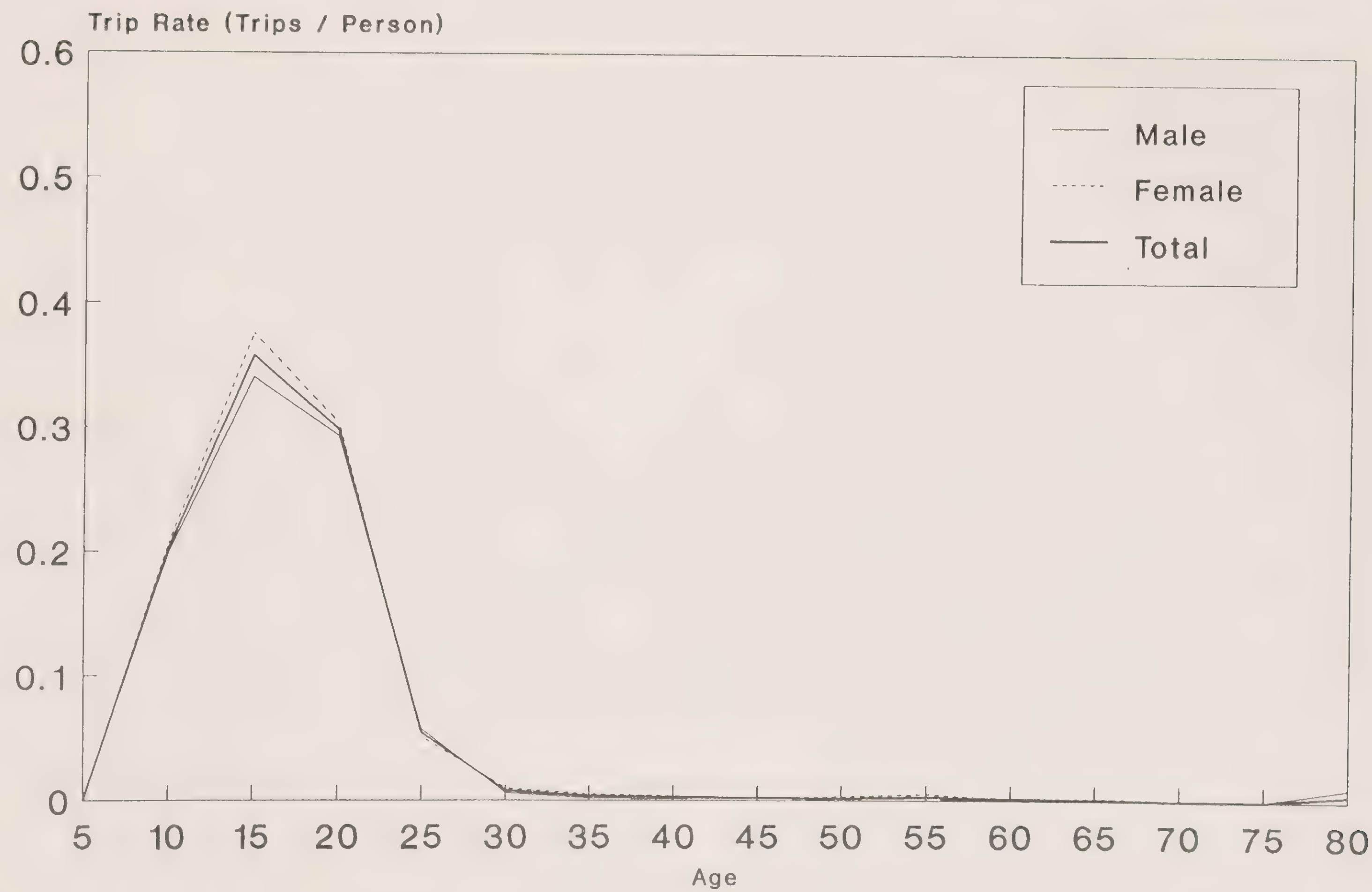
Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 2



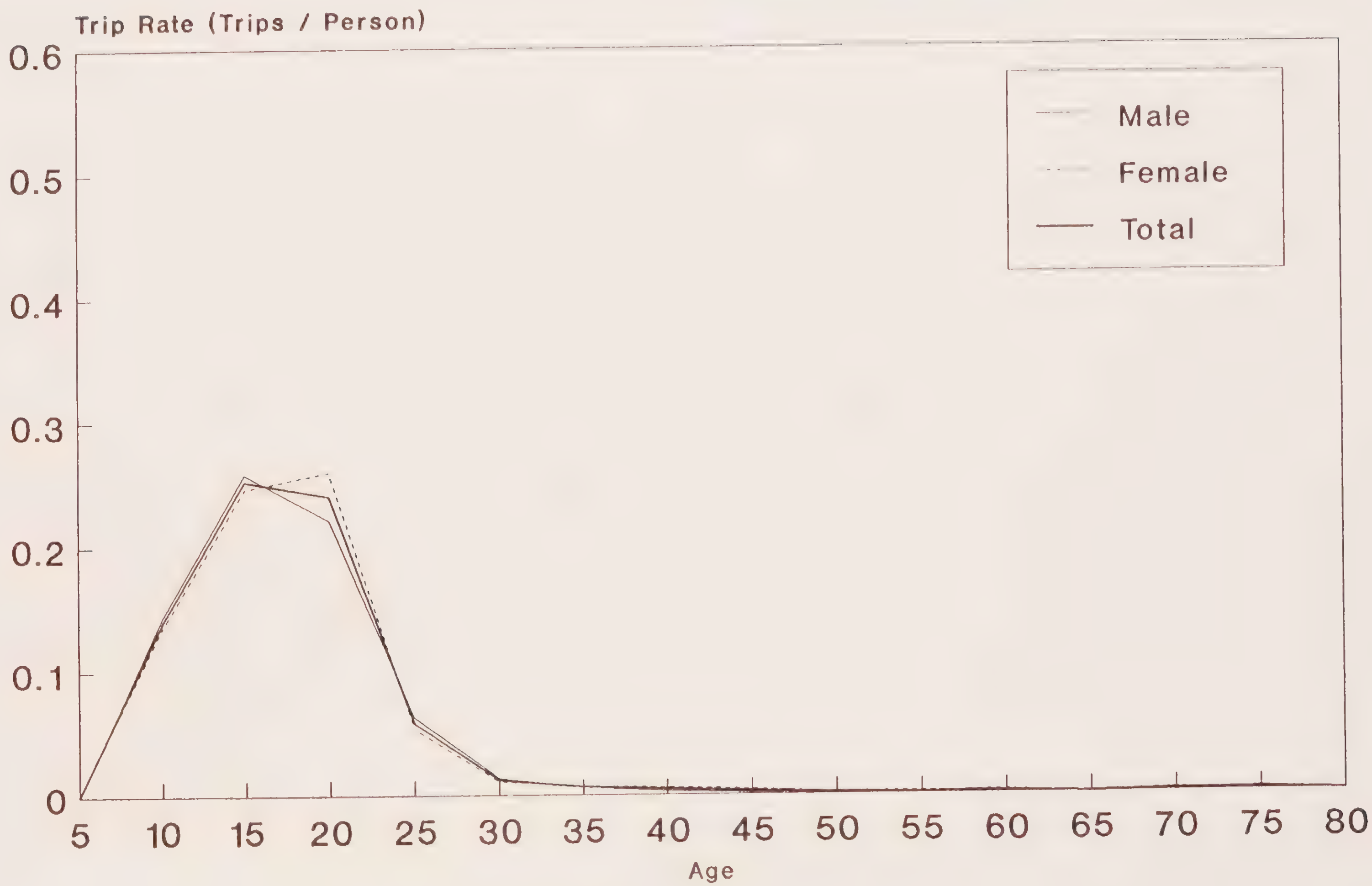
Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 3



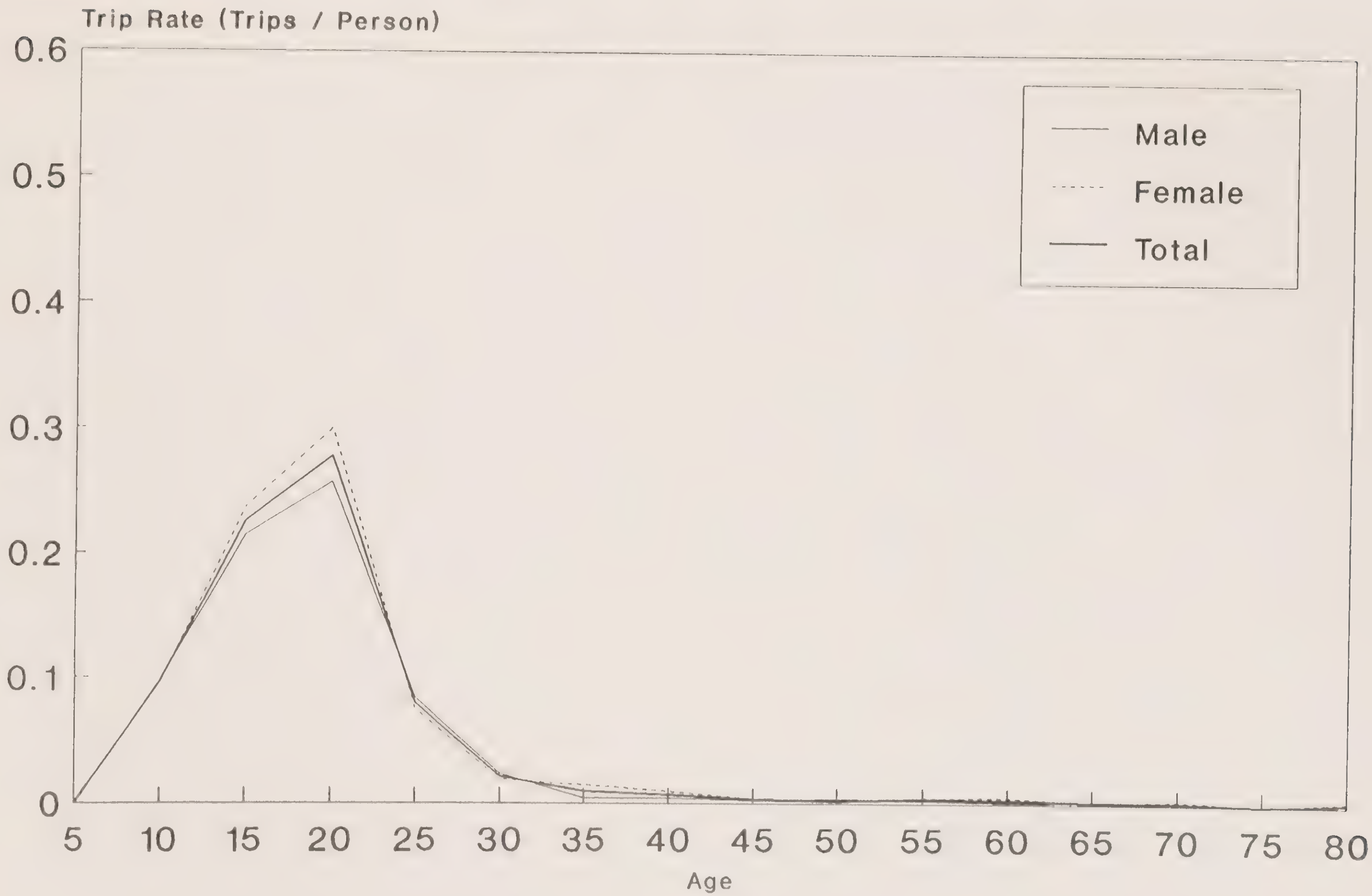
Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 3 (Metro)



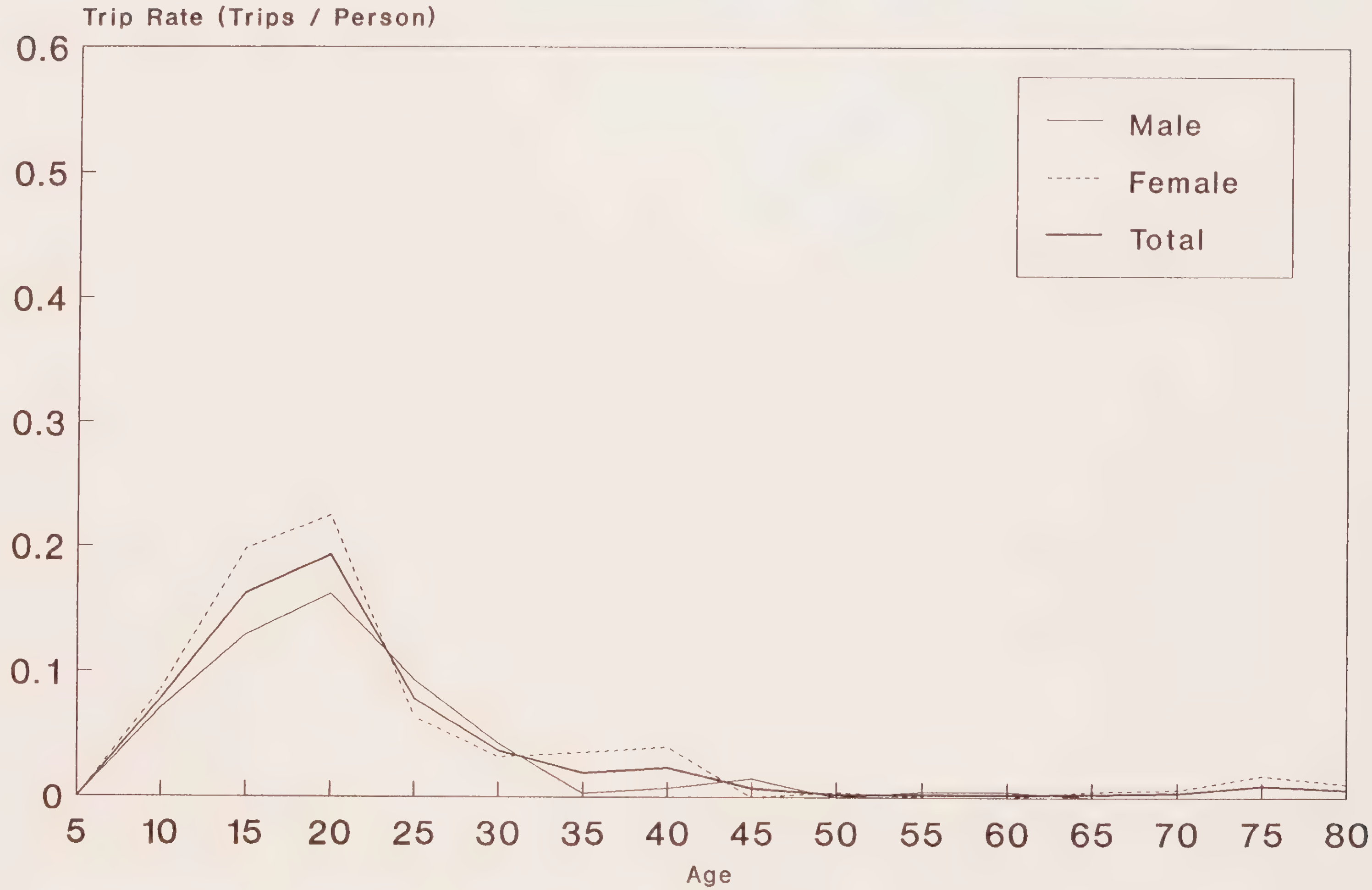
Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 4



Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 5



Home-Based Trip Chain Productions
Transit Mode, School Trips
Density Class 6



APPENDIX F

DENSITY CLASS DISCRIMINANT ANALYSIS MODEL

Define the following terms:

x	=	vector containing the population and employment density measures of an observation (i.e., for a given TARMS zone)
t	=	density class subscript, $t=1,...,6$
m_t	=	vector containing population and employment density means for zones in density class t
S_t	=	the covariance matrix within density class t
$\lvert S_t \rvert$	=	the determinant of S_t

Parametric Method : Assume that each density class has a multivariate normal distribution

The squared distance from observation x to the mean values for density class t is

$$d_t^2(x) = (x - m_t)' S_t^{-1} (x - m_t)$$

The generalized squared distance from x to density class t is defined as

$$D_t^2(x) = d_t^2(x) + g_1(t) + g_2(t)$$

where:

$g_1(t)$	=	$\ln \lvert S_t \rvert$	if the within-density-class covariance matrices are used
$g_2(t)$	=	0	if the prior probabilities are all equal

The posterior probability of x belonging to density class t is then equal to

$$p(t \mid x) = \frac{\exp(-0.5 D_t^2(x))}{\sum_u \exp(-0.5 D_u^2(x))}$$

An observation is classified into density class t if by doing so produces the largest value of $p(t \mid x)$ or correspondingly the smallest value of $D_t^2(x)$.

APPENDIX G

THE DEMOGRAPHIC MODEL

Define the following terms:

P_{jdr}^{t}	=	probability that a person belongs to age-sex category j, lives in a zone of density d in regional municipality r in year t
P_{jdr}^{P}	=	prior on P_{jdr}^{t}
POP_i^t	=	population in TARMS zone i in year t
δ_{id}^{t}	=	1 if TARMS zone i is in region r
	=	0 otherwise
$TPOP^t$	=	total population in year t = $\sum_i POP_i^t$
γ_{ir}	=	1 if TARMS zone i is in region r
	=	0 otherwise
X_{dr}^{t}	=	proportion of population in density class d in region r in year t
	=	$\dfrac{\sum_i POP_i^t \, \delta_{id}^t \, \gamma_{ir}}{TPOP^t}$
Y_{jr}^{t}	=	probability that a person belongs to age-sex category j and lives in region r in year t

Then the entropy maximization problem is given by:

$$\max_{\{P_{jdr}^t\}} S = -\sum_j \sum_d \sum_r P_{jdr}^t \log \left\{\frac{P_{jdr}^t}{P_{jdr}^p}\right\}$$

subject to :

$\sum_j P^t_{jdr} = X^t_{dr}$ $\quad \forall\ d,r$ proportion of population in density class d in region r must equal to known total

$\sum_d P^t_{jdr} = Y^t_{jr}$ $\quad \forall\ j,r$ proportion of population in age-sex category j in region r must equal to known total

The result is :

$$P^t_{jdr} = P^p_{jdr}\ A_{dr}\ B_{jr}\ X^t_{dr}\ Y^t_{jr}$$

where:

$$A_{dr} = \frac{1}{\sum_j P^p_{jdr}\ B_{jr}\ Y^t_{jr}}$$

$$B_{jr} = \frac{1}{\sum_d P^p_{jdr}\ A_{dr}\ X^t_{dr}}$$

The prior distribution $\{P_{jdr}^{P}\}$ is calculated as follows:

a) 2001 forecast : D_{jd}^{86} = proportion of population in density class d (GTA-wide) in age-sex category j in 1986

$$P_{jdr}^{P} = \frac{\sum_i (POP_i^{86}\ \delta_{id}^{86}\ \gamma_{ir}\ D_{jd}^{86})}{TPOP^{86}} \qquad \forall\ j,d,r$$

b) 2011 forecast : $P_{jdr}^{P} = P^{2001}_{jdr} \qquad \forall\ j,d,r$

APPENDIX H

AGE-GENDER DISTRIBUTIONS BY YEAR BY REGIONAL MUNICIPALITY BY DENSITY CLASS

This appendix presents tables of the projected age distributions of the population in each density class in each regional municipality for males and females for the years 2001 and 2011. These tables were generated using the demographic model described in Appendix G. As usual, five-year age categories are used, with the number shown under "age" indicating the upper bound of the given category.

Age Distribution for Male in the Year 2001

METROPOLITAN TORONTO

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.084	0.080	0.074	0.069	0.065	0.065
10	0.081	0.078	0.071	0.065	0.062	0.061
15	0.081	0.080	0.072	0.064	0.060	0.060
20	0.060	0.059	0.059	0.058	0.057	0.057
25	0.053	0.052	0.055	0.059	0.061	0.061
30	0.056	0.057	0.060	0.063	0.063	0.063
35	0.081	0.079	0.079	0.077	0.076	0.076
40	0.116	0.116	0.112	0.104	0.102	0.102
45	0.098	0.096	0.092	0.086	0.083	0.083
50	0.077	0.077	0.078	0.078	0.078	0.078
55	0.053	0.056	0.058	0.062	0.063	0.064
60	0.042	0.043	0.047	0.053	0.055	0.055
65	0.039	0.037	0.040	0.046	0.049	0.049
70	0.025	0.028	0.030	0.034	0.035	0.035
75	0.025	0.026	0.029	0.033	0.036	0.036
80	0.018	0.019	0.020	0.025	0.027	0.027
85	0.007	0.011	0.011	0.013	0.014	0.014
90	0.007	0.005	0.007	0.007	0.009	0.009
95	0.000	0.001	0.003	0.003	0.003	0.003

Age Distribution for Male in the Year 2001

DURHAM

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.098	0.097	0.090	0.083	0.090	0.079
10	0.076	0.075	0.069	0.063	0.069	0.058
15	0.084	0.084	0.077	0.068	0.077	0.064
20	0.069	0.070	0.069	0.068	0.069	0.067
25	0.070	0.071	0.076	0.082	0.076	0.084
30	0.071	0.072	0.076	0.080	0.076	0.080
35	0.082	0.081	0.081	0.080	0.081	0.078
40	0.092	0.091	0.088	0.082	0.087	0.080
45	0.084	0.085	0.081	0.076	0.081	0.074
50	0.073	0.073	0.074	0.074	0.074	0.075
55	0.056	0.057	0.060	0.064	0.060	0.066
60	0.043	0.043	0.047	0.053	0.047	0.055
65	0.033	0.033	0.036	0.040	0.036	0.043
70	0.025	0.023	0.026	0.029	0.026	0.030
75	0.019	0.019	0.021	0.024	0.021	0.027
80	0.013	0.013	0.015	0.018	0.015	0.019
85	0.009	0.009	0.009	0.010	0.009	0.011
90	0.004	0.003	0.004	0.004	0.004	0.004
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Male in the Year 2001

YORK

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.097	0.095	0.088	0.081	0.090	0.090
10	0.078	0.077	0.071	0.065	0.073	0.073
15	0.081	0.081	0.074	0.066	0.076	0.076
20	0.070	0.071	0.071	0.070	0.071	0.071
25	0.071	0.073	0.077	0.083	0.076	0.076
30	0.076	0.077	0.081	0.085	0.080	0.080
35	0.082	0.081	0.081	0.079	0.081	0.081
40	0.091	0.090	0.087	0.082	0.088	0.088
45	0.077	0.077	0.074	0.069	0.074	0.074
50	0.076	0.076	0.078	0.078	0.077	0.077
55	0.057	0.059	0.061	0.065	0.060	0.060
60	0.043	0.043	0.047	0.053	0.046	0.046
65	0.035	0.035	0.038	0.043	0.037	0.037
70	0.024	0.023	0.025	0.028	0.025	0.025
75	0.017	0.017	0.019	0.022	0.019	0.019
80	0.014	0.014	0.015	0.018	0.015	0.015
85	0.006	0.006	0.006	0.007	0.006	0.006
90	0.006	0.004	0.006	0.005	0.005	0.005
95	0.001	0.001	0.001	0.001	0.001	0.001

Age Distribution for Male in the Year 2001

PEEL

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.096	0.095	0.088	0.081	0.078	0.078
10	0.082	0.081	0.075	0.069	0.065	0.064
15	0.085	0.085	0.078	0.069	0.065	0.065
20	0.067	0.068	0.068	0.067	0.067	0.066
25	0.064	0.065	0.070	0.075	0.078	0.078
30	0.073	0.074	0.079	0.082	0.084	0.083
35	0.081	0.081	0.081	0.079	0.079	0.079
40	0.097	0.097	0.094	0.088	0.086	0.086
45	0.085	0.085	0.082	0.077	0.075	0.074
50	0.075	0.076	0.077	0.078	0.078	0.078
55	0.056	0.058	0.060	0.064	0.066	0.068
60	0.045	0.045	0.050	0.056	0.059	0.059
65	0.033	0.033	0.036	0.040	0.043	0.043
70	0.021	0.020	0.022	0.025	0.026	0.026
75	0.016	0.017	0.018	0.021	0.023	0.023
80	0.010	0.010	0.011	0.013	0.014	0.014
85	0.008	0.008	0.008	0.009	0.011	0.010
90	0.002	0.002	0.003	0.003	0.003	0.003
95	0.001	0.001	0.001	0.001	0.001	0.001

Age Distribution for Male in the Year 2001

HALTON

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.090	0.088	0.081	0.074	0.082	0.082
10	0.071	0.070	0.064	0.058	0.065	0.065
15	0.072	0.072	0.066	0.058	0.066	0.066
20	0.062	0.063	0.061	0.060	0.061	0.061
25	0.065	0.067	0.071	0.075	0.070	0.070
30	0.077	0.078	0.081	0.084	0.081	0.081
35	0.080	0.079	0.079	0.077	0.079	0.079
40	0.090	0.089	0.086	0.079	0.086	0.086
45	0.080	0.080	0.076	0.071	0.076	0.076
50	0.070	0.070	0.071	0.071	0.071	0.071
55	0.061	0.062	0.065	0.068	0.064	0.064
60	0.053	0.053	0.057	0.064	0.057	0.057
65	0.044	0.044	0.047	0.053	0.048	0.048
70	0.030	0.029	0.031	0.035	0.032	0.032
75	0.026	0.026	0.029	0.033	0.029	0.029
80	0.014	0.014	0.015	0.019	0.016	0.016
85	0.011	0.011	0.011	0.012	0.011	0.011
90	0.005	0.004	0.005	0.005	0.005	0.005
95	0.001	0.001	0.003	0.003	0.003	0.003

Age Distribution for Male in the Year 2001

HAMILTON-WENTWORTH

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.086	0.085	0.078	0.071	0.068	0.068
10	0.077	0.076	0.070	0.063	0.060	0.059
15	0.075	0.076	0.069	0.061	0.057	0.057
20	0.066	0.067	0.066	0.065	0.064	0.064
25	0.059	0.061	0.065	0.069	0.071	0.071
30	0.062	0.063	0.066	0.069	0.069	0.069
35	0.077	0.077	0.077	0.075	0.073	0.073
40	0.097	0.097	0.093	0.086	0.084	0.084
45	0.080	0.081	0.077	0.072	0.069	0.069
50	0.076	0.076	0.077	0.077	0.077	0.077
55	0.052	0.054	0.056	0.059	0.060	0.061
60	0.047	0.048	0.052	0.058	0.060	0.060
65	0.037	0.037	0.040	0.045	0.048	0.048
70	0.032	0.031	0.034	0.038	0.039	0.039
75	0.029	0.029	0.032	0.037	0.040	0.040
80	0.022	0.022	0.024	0.030	0.031	0.031
85	0.013	0.013	0.013	0.015	0.017	0.017
90	0.008	0.006	0.008	0.008	0.010	0.010
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Female in the Year 2001

METROPOLITAN TORONTO

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.077	0.074	0.067	0.060	0.057	0.056
10	0.077	0.072	0.065	0.057	0.053	0.053
15	0.077	0.073	0.066	0.058	0.055	0.054
20	0.057	0.055	0.053	0.051	0.050	0.050
25	0.047	0.047	0.050	0.055	0.056	0.056
30	0.060	0.058	0.061	0.064	0.064	0.065
35	0.084	0.080	0.079	0.076	0.074	0.075
40	0.121	0.116	0.109	0.101	0.099	0.099
45	0.094	0.093	0.089	0.083	0.080	0.080
50	0.081	0.077	0.077	0.078	0.078	0.078
55	0.050	0.054	0.056	0.059	0.060	0.060
60	0.044	0.043	0.046	0.051	0.053	0.053
65	0.040	0.042	0.047	0.053	0.056	0.056
70	0.030	0.034	0.040	0.045	0.049	0.049
75	0.034	0.031	0.038	0.044	0.047	0.048
80	0.017	0.025	0.029	0.034	0.035	0.035
85	0.010	0.013	0.015	0.019	0.019	0.019
90	0.000	0.007	0.010	0.011	0.013	0.013
95	0.000	0.002	0.004	0.004	0.004	0.004

Age Distribution for Female in the Year 2001

DURHAM

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.093	0.091	0.083	0.074	0.083	0.069
10	0.078	0.077	0.070	0.061	0.070	0.057
15	0.080	0.079	0.072	0.063	0.072	0.059
20	0.068	0.068	0.067	0.065	0.067	0.064
25	0.064	0.066	0.071	0.078	0.071	0.081
30	0.072	0.072	0.076	0.079	0.076	0.081
35	0.080	0.079	0.078	0.075	0.078	0.075
40	0.092	0.091	0.087	0.081	0.087	0.079
45	0.083	0.083	0.079	0.074	0.079	0.071
50	0.075	0.076	0.077	0.078	0.077	0.079
55	0.054	0.055	0.058	0.060	0.057	0.062
60	0.045	0.044	0.047	0.052	0.048	0.055
65	0.035	0.036	0.040	0.045	0.040	0.048
70	0.027	0.027	0.032	0.036	0.032	0.040
75	0.023	0.022	0.026	0.030	0.026	0.034
80	0.016	0.018	0.020	0.024	0.020	0.025
85	0.011	0.011	0.012	0.015	0.012	0.014
90	0.004	0.004	0.005	0.006	0.005	0.007
95	0.001	0.001	0.001	0.001	0.001	0.001

Age Distribution for Female in the Year 2001

YORK

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.095	0.093	0.085	0.077	0.088	0.088
10	0.076	0.075	0.068	0.059	0.070	0.070
15	0.077	0.076	0.069	0.061	0.071	0.071
20	0.071	0.072	0.070	0.069	0.071	0.071
25	0.063	0.065	0.070	0.077	0.069	0.069
30	0.081	0.081	0.086	0.090	0.085	0.085
35	0.083	0.082	0.081	0.079	0.081	0.081
40	0.091	0.092	0.087	0.081	0.088	0.088
45	0.076	0.076	0.073	0.068	0.073	0.073
50	0.073	0.074	0.074	0.075	0.074	0.074
55	0.055	0.056	0.059	0.061	0.058	0.058
60	0.049	0.048	0.051	0.056	0.050	0.050
65	0.035	0.036	0.040	0.045	0.039	0.039
70	0.024	0.024	0.028	0.032	0.027	0.027
75	0.024	0.023	0.027	0.032	0.026	0.026
80	0.013	0.013	0.015	0.018	0.015	0.015
85	0.008	0.008	0.009	0.011	0.009	0.009
90	0.004	0.004	0.005	0.006	0.005	0.005
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Female in the Year 2001

PEEL

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.094	0.092	0.085	0.076	0.072	0.071
10	0.083	0.082	0.074	0.066	0.061	0.061
15	0.080	0.079	0.072	0.064	0.061	0.060
20	0.067	0.068	0.067	0.065	0.064	0.064
25	0.060	0.061	0.067	0.073	0.075	0.076
30	0.072	0.072	0.077	0.080	0.082	0.082
35	0.086	0.085	0.084	0.082	0.081	0.082
40	0.099	0.099	0.094	0.089	0.087	0.087
45	0.082	0.082	0.079	0.074	0.072	0.072
50	0.073	0.075	0.075	0.077	0.077	0.077
55	0.058	0.059	0.062	0.065	0.067	0.067
60	0.044	0.043	0.046	0.052	0.054	0.054
65	0.036	0.037	0.041	0.047	0.050	0.050
70	0.024	0.024	0.027	0.032	0.035	0.034
75	0.018	0.017	0.021	0.025	0.026	0.027
80	0.013	0.014	0.016	0.019	0.020	0.019
85	0.006	0.006	0.007	0.009	0.009	0.009
90	0.004	0.004	0.005	0.006	0.007	0.007
95	0.001	0.001	0.001	0.001	0.001	0.001

Age Distribution for Female in the Year 2001

HALTON

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.085	0.083	0.075	0.067	0.076	0.076
10	0.068	0.067	0.060	0.053	0.061	0.061
15	0.067	0.066	0.060	0.052	0.060	0.060
20	0.064	0.065	0.062	0.060	0.063	0.063
25	0.063	0.064	0.069	0.074	0.069	0.069
30	0.072	0.072	0.076	0.078	0.075	0.075
35	0.082	0.081	0.079	0.076	0.079	0.079
40	0.090	0.090	0.085	0.078	0.085	0.085
45	0.076	0.076	0.072	0.067	0.072	0.072
50	0.071	0.072	0.071	0.072	0.072	0.072
55	0.062	0.064	0.066	0.068	0.066	0.066
60	0.053	0.052	0.055	0.060	0.055	0.055
65	0.045	0.046	0.051	0.057	0.051	0.051
70	0.037	0.037	0.042	0.048	0.042	0.042
75	0.024	0.022	0.027	0.031	0.026	0.026
80	0.024	0.026	0.029	0.034	0.029	0.029
85	0.011	0.011	0.012	0.015	0.012	0.012
90	0.005	0.005	0.006	0.007	0.006	0.006
95	0.001	0.001	0.003	0.003	0.002	0.002

Age Distribution for Female in the Year 2001

HAMILTON-WENTWORTH

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.081	0.080	0.072	0.064	0.060	0.059
10	0.071	0.070	0.063	0.054	0.050	0.050
15	0.071	0.070	0.063	0.055	0.052	0.051
20	0.060	0.061	0.059	0.056	0.055	0.055
25	0.055	0.057	0.061	0.065	0.066	0.067
30	0.064	0.064	0.066	0.068	0.069	0.070
35	0.076	0.075	0.074	0.070	0.069	0.070
40	0.099	0.099	0.092	0.085	0.083	0.083
45	0.079	0.079	0.075	0.069	0.067	0.067
50	0.073	0.074	0.073	0.074	0.073	0.073
55	0.052	0.054	0.055	0.057	0.058	0.058
60	0.049	0.048	0.050	0.055	0.057	0.057
65	0.042	0.043	0.047	0.053	0.056	0.056
70	0.036	0.036	0.042	0.047	0.051	0.051
75	0.039	0.037	0.044	0.050	0.054	0.055
80	0.027	0.029	0.033	0.038	0.040	0.040
85	0.016	0.016	0.018	0.021	0.021	0.021
90	0.010	0.010	0.013	0.015	0.018	0.018
95	0.001	0.001	0.001	0.001	0.001	0.001

Age Distribution for Male in the Year 2011

METROPOLITAN TORONTO

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.070	0.066	0.060	0.055	0.052	0.052
10	0.058	0.058	0.052	0.047	0.044	0.043
15	0.070	0.068	0.061	0.054	0.050	0.050
20	0.070	0.070	0.068	0.066	0.065	0.065
25	0.066	0.066	0.069	0.073	0.075	0.075
30	0.058	0.058	0.060	0.062	0.062	0.062
35	0.062	0.060	0.059	0.057	0.055	0.055
40	0.078	0.076	0.073	0.067	0.065	0.065
45	0.089	0.086	0.081	0.075	0.072	0.072
50	0.101	0.100	0.101	0.099	0.098	0.098
55	0.074	0.078	0.080	0.084	0.085	0.086
60	0.062	0.062	0.067	0.075	0.077	0.077
65	0.050	0.049	0.053	0.059	0.062	0.062
70	0.027	0.029	0.031	0.034	0.035	0.035
75	0.023	0.026	0.028	0.032	0.034	0.034
80	0.019	0.021	0.023	0.028	0.029	0.029
85	0.012	0.016	0.016	0.018	0.020	0.020
90	0.012	0.008	0.012	0.011	0.014	0.014
95	0.000	0.002	0.004	0.004	0.004	0.004

Age Distribution for Male in the Year 2011

DURHAM

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.091	0.090	0.083	0.076	0.082	0.072
10	0.069	0.068	0.062	0.056	0.061	0.052
15	0.078	0.078	0.071	0.063	0.070	0.058
20	0.068	0.069	0.067	0.066	0.067	0.065
25	0.069	0.071	0.075	0.080	0.076	0.083
30	0.067	0.068	0.071	0.074	0.071	0.074
35	0.073	0.072	0.072	0.070	0.071	0.068
40	0.080	0.080	0.076	0.071	0.075	0.069
45	0.077	0.077	0.074	0.068	0.073	0.067
50	0.074	0.074	0.075	0.074	0.074	0.075
55	0.063	0.065	0.067	0.071	0.068	0.073
60	0.057	0.057	0.062	0.069	0.063	0.072
65	0.047	0.047	0.051	0.057	0.052	0.061
70	0.031	0.029	0.032	0.036	0.033	0.037
75	0.021	0.021	0.023	0.027	0.024	0.029
80	0.015	0.016	0.017	0.020	0.018	0.022
85	0.012	0.012	0.012	0.014	0.013	0.015
90	0.006	0.004	0.006	0.006	0.005	0.006
95	0.002	0.002	0.003	0.003	0.003	0.003

Age Distribution for Male in the Year 2011

YORK

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.090	0.088	0.081	0.074	0.082	0.082
10	0.072	0.071	0.065	0.059	0.066	0.066
15	0.078	0.079	0.071	0.063	0.072	0.072
20	0.068	0.069	0.068	0.067	0.068	0.068
25	0.067	0.069	0.073	0.078	0.073	0.073
30	0.069	0.070	0.074	0.077	0.073	0.073
35	0.072	0.071	0.071	0.069	0.071	0.071
40	0.086	0.085	0.082	0.076	0.082	0.082
45	0.077	0.077	0.073	0.068	0.073	0.073
50	0.075	0.075	0.076	0.076	0.076	0.076
55	0.059	0.060	0.063	0.066	0.063	0.063
60	0.054	0.054	0.059	0.066	0.059	0.059
65	0.049	0.050	0.053	0.060	0.054	0.054
70	0.030	0.029	0.031	0.035	0.031	0.031
75	0.020	0.020	0.022	0.025	0.022	0.022
80	0.018	0.018	0.019	0.023	0.019	0.019
85	0.008	0.009	0.008	0.009	0.009	0.009
90	0.008	0.006	0.008	0.007	0.007	0.007
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Male in the Year 20[illegible]1

PEEL

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.087	0.085	0.078	0.072	0.068	0.069
10	0.072	0.071	0.065	0.059	0.056	0.055
15	0.078	0.078	0.071	0.062	0.058	0.059
20	0.067	0.068	0.067	0.065	0.064	0.064
25	0.063	0.065	0.069	0.074	0.076	0.075
30	0.068	0.069	0.072	0.075	0.075	0.075
35	0.071	0.070	0.070	0.068	0.067	0.067
40	0.084	0.083	0.080	0.074	0.072	0.072
45	0.080	0.080	0.076	0.071	0.068	0.068
50	0.079	0.079	0.080	0.079	0.079	0.079
55	0.061	0.063	0.065	0.069	0.070	0.071
60	0.058	0.058	0.063	0.071	0.073	0.074
65	0.048	0.048	0.052	0.058	0.062	0.062
70	0.030	0.029	0.031	0.035	0.036	0.036
75	0.022	0.022	0.025	0.028	0.030	0.031
80	0.013	0.014	0.015	0.018	0.019	0.018
85	0.013	0.013	0.013	0.015	0.017	0.016
90	0.004	0.003	0.004	0.004	0.005	0.005
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Male in the Year 20¦1

HALTON

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.080	0.078	0.072	0.066	0.072	0.072
10	0.067	0.066	0.060	0.054	0.061	0.061
15	0.074	0.074	0.067	0.059	0.066	0.066
20	0.062	0.063	0.061	0.060	0.061	0.061
25	0.061	0.062	0.066	0.070	0.066	0.066
30	0.066	0.067	0.070	0.073	0.070	0.070
35	0.068	0.067	0.066	0.064	0.066	0.066
40	0.086	0.086	0.082	0.076	0.081	0.081
45	0.088	0.088	0.083	0.077	0.083	0.083
50	0.073	0.073	0.074	0.073	0.073	0.073
55	0.057	0.059	0.061	0.064	0.061	0.061
60	0.056	0.056	0.061	0.068	0.061	0.061
65	0.056	0.056	0.061	0.068	0.061	0.061
70	0.036	0.035	0.037	0.042	0.038	0.038
75	0.028	0.028	0.031	0.036	0.032	0.032
80	0.017	0.017	0.019	0.023	0.019	0.019
85	0.016	0.016	0.016	0.018	0.016	0.016
90	0.008	0.006	0.008	0.008	0.008	0.008
95	0.002	0.002	0.005	0.005	0.004	0.004

Age Distribution for Male in the Year 2011

HAMILTON-WENTWORTH

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.077	0.076	0.069	0.063	0.059	0.059
10	0.065	0.065	0.059	0.053	0.050	0.049
15	0.069	0.069	0.062	0.054	0.051	0.050
20	0.070	0.071	0.069	0.067	0.066	0.066
25	0.065	0.067	0.071	0.075	0.076	0.076
30	0.061	0.062	0.065	0.066	0.067	0.067
35	0.065	0.065	0.064	0.062	0.060	0.060
40	0.076	0.076	0.073	0.067	0.064	0.065
45	0.075	0.075	0.071	0.066	0.063	0.063
50	0.087	0.087	0.088	0.087	0.086	0.086
55	0.064	0.065	0.067	0.071	0.071	0.073
60	0.063	0.064	0.069	0.076	0.078	0.078
65	0.049	0.049	0.053	0.059	0.062	0.062
70	0.033	0.032	0.035	0.038	0.040	0.039
75	0.026	0.026	0.029	0.033	0.035	0.035
80	0.022	0.023	0.024	0.030	0.031	0.031
85	0.018	0.018	0.018	0.020	0.022	0.022
90	0.012	0.009	0.012	0.012	0.015	0.015
95	0.001	0.001	0.003	0.003	0.003	0.003

Age Distribution for Female in the Year 2011

METROPOLITAN TORONTO

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.064	0.061	0.054	0.047	0.045	0.044
10	0.060	0.054	0.047	0.041	0.038	0.038
15	0.067	0.062	0.055	0.048	0.045	0.044
20	0.067	0.064	0.061	0.058	0.056	0.056
25	0.060	0.060	0.063	0.067	0.068	0.068
30	0.060	0.058	0.060	0.061	0.061	0.061
35	0.064	0.059	0.057	0.054	0.052	0.053
40	0.079	0.076	0.070	0.064	0.062	0.062
45	0.086	0.083	0.078	0.071	0.068	0.068
50	0.105	0.099	0.097	0.096	0.096	0.095
55	0.071	0.074	0.076	0.078	0.079	0.078
60	0.064	0.061	0.064	0.069	0.071	0.071
65	0.052	0.055	0.059	0.066	0.069	0.069
70	0.034	0.037	0.042	0.047	0.051	0.051
75	0.034	0.032	0.038	0.044	0.046	0.048
80	0.019	0.030	0.034	0.039	0.040	0.040
85	0.015	0.020	0.023	0.028	0.027	0.027
90	0.000	0.012	0.015	0.018	0.021	0.021
95	0.000	0.003	0.006	0.006	0.006	0.005

Age Distribution for Female in the Year 2011

DURHAM

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.086	0.084	0.077	0.068	0.076	0.063
10	0.071	0.070	0.063	0.055	0.062	0.050
15	0.074	0.073	0.066	0.058	0.065	0.053
20	0.066	0.067	0.065	0.062	0.064	0.061
25	0.064	0.065	0.070	0.075	0.070	0.078
30	0.068	0.068	0.071	0.073	0.071	0.075
35	0.071	0.070	0.069	0.066	0.068	0.065
40	0.080	0.080	0.075	0.069	0.074	0.067
45	0.075	0.075	0.071	0.066	0.071	0.063
50	0.076	0.077	0.077	0.077	0.077	0.078
55	0.061	0.063	0.065	0.067	0.065	0.069
60	0.060	0.059	0.062	0.068	0.064	0.071
65	0.049	0.051	0.055	0.063	0.057	0.066
70	0.033	0.033	0.038	0.043	0.039	0.047
75	0.025	0.023	0.028	0.032	0.029	0.036
80	0.019	0.020	0.023	0.027	0.023	0.028
85	0.014	0.014	0.016	0.019	0.017	0.018
90	0.006	0.006	0.007	0.009	0.008	0.010
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Female in the Year 2011

YORK

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.088	0.087	0.079	0.070	0.079	0.079
10	0.071	0.070	0.063	0.054	0.063	0.063
15	0.075	0.074	0.066	0.058	0.067	0.067
20	0.068	0.069	0.067	0.065	0.067	0.067
25	0.060	0.061	0.066	0.071	0.065	0.065
30	0.074	0.074	0.077	0.080	0.077	0.077
35	0.073	0.072	0.071	0.068	0.070	0.070
40	0.086	0.086	0.081	0.075	0.081	0.081
45	0.075	0.075	0.071	0.066	0.071	0.071
50	0.071	0.072	0.071	0.072	0.071	0.071
55	0.056	0.057	0.059	0.062	0.059	0.059
60	0.062	0.061	0.064	0.071	0.065	0.065
65	0.049	0.050	0.055	0.062	0.055	0.055
70	0.030	0.030	0.034	0.039	0.034	0.034
75	0.028	0.027	0.032	0.037	0.032	0.032
80	0.016	0.017	0.019	0.023	0.019	0.019
85	0.011	0.011	0.013	0.015	0.013	0.013
90	0.006	0.006	0.007	0.008	0.007	0.007
95	0.002	0.002	0.003	0.003	0.003	0.003

Age Distribution for Female in the Year 2011

PEEL

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.084	0.082	0.075	0.066	0.063	0.062
10	0.073	0.071	0.064	0.056	0.052	0.052
15	0.073	0.072	0.065	0.057	0.054	0.053
20	0.066	0.067	0.065	0.063	0.061	0.062
25	0.059	0.061	0.065	0.070	0.071	0.073
30	0.067	0.067	0.070	0.072	0.073	0.073
35	0.074	0.074	0.072	0.069	0.068	0.069
40	0.086	0.086	0.080	0.074	0.073	0.073
45	0.077	0.077	0.073	0.068	0.066	0.065
50	0.076	0.078	0.077	0.078	0.078	0.078
55	0.063	0.064	0.067	0.069	0.070	0.071
60	0.056	0.055	0.058	0.064	0.067	0.067
65	0.052	0.053	0.059	0.066	0.070	0.071
70	0.033	0.033	0.038	0.043	0.046	0.046
75	0.024	0.023	0.028	0.032	0.034	0.035
80	0.018	0.020	0.022	0.026	0.027	0.026
85	0.010	0.010	0.012	0.014	0.014	0.014
90	0.006	0.007	0.008	0.010	0.011	0.011
95	0.001	0.001	0.002	0.002	0.002	0.002

Age Distribution for Female in the Year 2011

HALTON

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.075	0.074	0.066	0.058	0.066	0.066
10	0.064	0.063	0.056	0.049	0.056	0.056
15	0.068	0.067	0.060	0.052	0.060	0.060
20	0.063	0.064	0.062	0.059	0.062	0.062
25	0.058	0.059	0.063	0.068	0.063	0.063
30	0.062	0.062	0.064	0.066	0.064	0.064
35	0.068	0.068	0.066	0.063	0.066	0.066
40	0.086	0.086	0.080	0.074	0.080	0.080
45	0.082	0.082	0.078	0.071	0.077	0.077
50	0.073	0.074	0.073	0.073	0.073	0.073
55	0.058	0.060	0.061	0.063	0.061	0.061
60	0.056	0.055	0.058	0.063	0.059	0.059
65	0.058	0.059	0.065	0.073	0.065	0.065
70	0.044	0.044	0.050	0.056	0.050	0.050
75	0.026	0.025	0.029	0.034	0.029	0.029
80	0.029	0.032	0.035	0.041	0.036	0.036
85	0.017	0.016	0.018	0.022	0.019	0.019
90	0.008	0.008	0.010	0.011	0.010	0.010
95	0.002	0.002	0.004	0.004	0.004	0.004

Age Distribution for Female in the Year 2011

HAMILTON-WENTWORTH

Age	Density Class 1	Density Class 2	Density Class 3	Density Class 4	Density Class 5	Density Class 6
5	0.073	0.071	0.064	0.056	0.052	0.052
10	0.060	0.059	0.052	0.045	0.041	0.041
15	0.064	0.063	0.056	0.049	0.046	0.045
20	0.063	0.063	0.061	0.058	0.056	0.056
25	0.060	0.062	0.066	0.070	0.071	0.071
30	0.062	0.062	0.064	0.065	0.065	0.066
35	0.063	0.062	0.061	0.057	0.055	0.056
40	0.077	0.077	0.071	0.065	0.063	0.062
45	0.074	0.074	0.069	0.063	0.060	0.061
50	0.083	0.084	0.082	0.082	0.081	0.081
55	0.063	0.065	0.066	0.067	0.068	0.068
60	0.064	0.063	0.066	0.071	0.074	0.074
65	0.053	0.055	0.059	0.066	0.069	0.070
70	0.038	0.038	0.043	0.048	0.052	0.052
75	0.036	0.034	0.040	0.046	0.048	0.050
80	0.028	0.030	0.033	0.038	0.040	0.040
85	0.022	0.022	0.024	0.029	0.028	0.028
90	0.016	0.016	0.020	0.023	0.027	0.026
95	0.001	0.001	0.002	0.002	0.002	0.001

APPENDIX I

SUMMARY OUTPUTS FOR SCENARIOS EXAMINED

BASE CASE SUMMARY OUTPUT

"Base" Scenario for 2001 and 2011

Table 1 : Number of Trips for All Purposes, 24 Hours
Note : Trips do NOT include walk trips.

Regional Municipality	Trips			Mode Split (% auto)		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1747407	1976760	2005080	70.3	72.8	72.6
Durham	276293	485762	571507	90.1	89.1	88.9
York	304073	603494	776494	86.7	89.1	89.1
Peel	494685	837779	940578	87.4	87.9	87.6
Halton	254240	361726	446016	91.1	90.2	90.0
Hamilton-Went.	352669	416881	420979	86.2	86.6	86.9

Regional Municipality	Auto Trips			Transit Trips		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1227681	1438894	1454881	519727	537866	550199
Durham	248853	432704	507836	27440	53058	63671
York	263765	537902	692007	40308	65592	84487
Peel	432572	736369	824061	62112	101410	116517
Halton	231615	326341	401542	22625	35385	44474
Hamilton-Went.	303983	361167	365751	48686	55714	55228

Trip Rates for 24-Hour Work Trips: "Base" Case

Total 24-Hour Work Trips All Modes

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.409	0.436	0.430	0.461	0.509	0.510	0.358	0.369	0.357
Durham	0.354	0.425	0.390	0.440	0.513	0.471	0.268	0.337	0.308
York	0.372	0.430	0.418	0.454	0.519	0.506	0.293	0.340	0.330
Peel	0.402	0.445	0.426	0.465	0.525	0.507	0.339	0.365	0.345
Halton	0.371	0.429	0.411	0.452	0.522	0.503	0.290	0.338	0.322
Hamilton-Went	0.323	0.414	0.406	0.392	0.500	0.496	0.257	0.332	0.321

Total 24-Hour Work Trips, Auto Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.249	0.276	0.270	0.330	0.372	0.370	0.172	0.187	0.179
Durham	0.312	0.374	0.343	0.402	0.465	0.428	0.225	0.282	0.259
York	0.324	0.377	0.366	0.414	0.472	0.459	0.236	0.282	0.272
Peel	0.342	0.386	0.368	0.420	0.480	0.461	0.265	0.293	0.275
Halton	0.328	0.387	0.367	0.412	0.484	0.462	0.245	0.292	0.275
Hamilton-Went	0.263	0.339	0.334	0.343	0.441	0.439	0.186	0.241	0.235

Total 24-Hour Work Trips, Transit Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.137	0.140	0.139	0.110	0.117	0.120	0.163	0.161	0.157
Durham	0.026	0.034	0.029	0.023	0.030	0.026	0.029	0.037	0.032
York	0.038	0.039	0.038	0.032	0.034	0.034	0.045	0.045	0.043
Peel	0.048	0.043	0.044	0.037	0.034	0.035	0.059	0.053	0.053
Halton	0.030	0.027	0.028	0.031	0.025	0.027	0.029	0.028	0.029
Hamilton-Went	0.038	0.047	0.045	0.028	0.035	0.034	0.046	0.059	0.056

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	54364	1868	43640	35844	1829	19
Durham	32953	72380	9262	3139	89	11
York	48362	1363	85335	13237	261	1
Peel	22705	37	8218	139817	4946	733
Halton	4437	-69	554	17344	43951	3627
Hamilton-Went.	468	-59	57	2131	12037	45931

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	33744	1898	36583	32816	1427	12
Durham	25850	64826	9216	3139	89	11
York	39761	1327	77037	13013	261	10
Peel	20776	37	7998	122874	4860	721
Halton	3960	-55	246	17167	39719	3552
Hamilton-Went.	276	-59	57	2105	11597	36249

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	20702	-69	6788	3026	373	7
Durham	7093	2967	46	0	0	0
York	8519	0	3467	224	0	-9
Peel	1898	0	220	9933	104	12
Halton	476	-14	308	131	1588	75
Hamilton-Went.	192	0	0	26	380	5928

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	7.2	20.8	81.8	71.7	47.2	1.5
Durham	106.9	96.5	195.4	211.7	69.0	16.2
York	74.1	63.6	156.8	214.5	65.4	1.4
Peel	25.1	5.9	114.2	110.6	83.3	50.9
Halton	23.4	-34.7	65.3	98.8	86.3	37.8
Hamilton-Went.	12.0	-57.8	24.6	96.5	79.6	39.8

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	7.9	22.0	80.0	70.9	38.9	1.0
Durham	101.8	96.1	195.7	211.7	69.0	16.2
York	73.8	62.5	156.5	212.7	65.4	20.0
Peel	29.1	5.9	113.4	110.6	84.4	51.0
Halton	29.9	-31.3	30.6	99.0	86.5	37.9
Hamilton-Went.	10.5	-57.8	24.6	97.4	78.8	39.6

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	7.4	-22.3	91.8	81.5	214.4	9.6
Durham	131.0	103.1	158.6	ERR	ERR	ERR
York	75.6	ERR	170.9	422.6	ERR	-39.1
Peel	10.0	ERR	148.6	112.5	74.3	46.2
Halton	8.3	-60.9	684.4	82.9	84.0	33.8
Hamilton-Went.	15.1	ERR	ERR	56.5	103.8	41.1

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986
for year 2011 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	67515	5389	44657	24086	1824	-194
Durham	34062	101800	12075	2382	73	9
York	74199	2624	135067	15261	359	0
Peel	47923	463	9755	153349	7302	755
Halton	12704	35	935	21163	68147	3392
Hamilton-Went.	1279	-42	71	1959	18339	39282

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	39538	5301	37268	22026	1441	-192
Durham	26763	90846	12019	2382	73	9
York	60675	2552	121000	14982	359	9
Peel	40320	463	9479	134528	7158	753
Halton	9760	47	522	20923	61090	3319
Hamilton-Went.	786	-42	71	1929	17672	30996

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	26313	23	7112	2060	354	-2
Durham	7286	4380	56	0	0	0
York	13401	0	5913	279	0	-9
Peel	7559	0	276	10941	160	2
Halton	2943	-12	413	171	2587	73
Hamilton-Went.	493	0	0	30	578	5076

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986
for year 2011 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	8.9	60.1	83.7	48.2	47.1	-14.8
Durham	110.5	135.7	254.8	160.6	56.6	13.2
York	113.7	122.5	248.1	247.3	90.0	0.0
Peel	53.0	73.6	135.5	121.3	123.0	52.5
Halton	67.0	17.6	110.3	120.6	133.8	35.3
Hamilton-Went.	32.7	-41.2	30.6	88.7	121.3	34.1

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	9.3	61.6	81.5	47.6	39.2	-15.6
Durham	105.4	134.7	255.2	160.6	56.6	13.2
York	112.6	120.3	245.8	244.9	90.0	18.0
Peel	56.4	73.6	134.5	121.1	124.3	53.3
Halton	73.7	26.7	65.0	120.7	133.0	35.4
Hamilton-Went.	29.9	-41.2	30.6	89.2	120.0	33.8

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	9.3	7.4	96.2	55.5	203.4	-2.7
Durham	134.6	152.2	193.1	ERR	ERR	ERR
York	118.9	ERR	291.4	526.4	ERR	-39.1
Peel	40.0	ERR	186.5	124.0	114.3	7.7
Halton	51.4	-52.2	917.8	108.2	136.9	32.9
Hamilton-Went.	38.7	ERR	ERR	65.2	157.9	35.2

SCENARIO 1 SUMMARY OUTPUT

Scenario #1 for 2001 and 2011

Table 1 : Number of Trips for All Purposes, 24 Hours
Note : Trips do NOT include walk trips.

Regional Municipality	Trips			Mode Split (% auto)		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1747407	2098992	2180340	70.3	71.6	70.4
Durham	276293	457835	532877	90.1	89.1	88.7
York	304073	558957	708997	86.7	88.9	88.6
Peel	494685	793199	879442	87.4	87.7	87.2
Halton	254240	344482	416729	91.1	90.1	89.8
Hamilton-Went.	352669	406482	409961	86.2	86.6	86.8

Regional Municipality	Auto Trips			Transit Trips		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1227681	1502656	1533994	519727	596336	646346
Durham	248853	408051	472897	27440	49784	59980
York	263765	497006	628252	40308	61951	80745
Peel	432572	695616	767211	62112	97583	112231
Halton	231615	310245	374060	22625	34237	42669
Hamilton-Went.	303983	351875	355826	48686	54607	54135

Trip Rates for 24-Hour Work Trips : Scenario #1

Total 24-Hour Work Trips All Modes

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.409	0.437	0.429	0.461	0.508	0.507	0.358	0.371	0.358
Durham	0.354	0.424	0.394	0.440	0.513	0.478	0.268	0.334	0.310
York	0.372	0.430	0.416	0.454	0.519	0.506	0.293	0.339	0.326
Peel	0.402	0.445	0.425	0.465	0.525	0.506	0.339	0.365	0.344
Halton	0.371	0.428	0.409	0.452	0.522	0.501	0.290	0.336	0.319
Hamilton-Went	0.323	0.412	0.405	0.392	0.498	0.495	0.257	0.330	0.320

Total 24-Hour Work Trips, Auto Mode

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.249	0.267	0.254	0.330	0.362	0.349	0.172	0.180	0.166
Durham	0.312	0.372	0.344	0.402	0.464	0.431	0.225	0.279	0.258
York	0.324	0.375	0.358	0.414	0.471	0.454	0.236	0.278	0.262
Peel	0.342	0.385	0.363	0.420	0.478	0.457	0.265	0.292	0.270
Halton	0.328	0.384	0.363	0.412	0.481	0.457	0.245	0.288	0.271
Hamilton-Went	0.263	0.337	0.333	0.343	0.440	0.438	0.186	0.240	0.234

Total 24-Hour Work Trips, Transit Mode

Regional Municipality	Total			Male			Female		
	'86	'01	'11	'86	'01	'11	'86	'01	'11
Metro Toronto	0.137	0.146	0.151	0.110	0.124	0.132	0.163	0.167	0.168
Durham	0.026	0.034	0.033	0.023	0.032	0.031	0.029	0.037	0.035
York	0.038	0.042	0.045	0.032	0.036	0.039	0.045	0.047	0.050
Peel	0.048	0.046	0.048	0.037	0.037	0.040	0.059	0.055	0.057
Halton	0.030	0.029	0.031	0.031	0.029	0.031	0.029	0.030	0.031
Hamilton-Went	0.038	0.047	0.046	0.028	0.035	0.034	0.046	0.059	0.057

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	138454	1721	39150	30836	1265	-204
Durham	32488	60543	7518	2372	43	-10
York	48567	1030	68458	10212	137	-18
Peel	27913	-14	6855	113438	3501	243
Halton	6760	-68	528	15660	36160	1868
Hamilton-Went.	1730	-46	87	2573	12196	39040

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	68895	1715	32392	27791	895	-208
Durham	25438	54471	7477	2372	43	-10
York	39632	1004	61763	10022	137	-5
Peel	24042	-14	6654	100675	3439	242
Halton	5473	-55	225	15495	32722	1832
Hamilton-Went.	1065	-46	87	2538	11759	30733

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	60235	-30	6533	3044	351	4
Durham	7038	2321	41	0	0	0
York	8863	0	2807	190	0	-13
Peel	3840	0	201	7572	78	1
Halton	1286	-13	303	122	1295	36
Hamilton-Went.	665	0	0	35	379	5095

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	18.3	19.2	73.4	61.7	32.7	-15.6
Durham	105.4	80.7	158.6	159.9	33.3	-14.7
York	74.4	48.1	125.8	165.5	34.3	-24.7
Peel	30.9	-2.2	95.2	89.7	59.0	16.9
Halton	35.6	-34.2	62.3	89.2	71.0	19.4
Hamilton-Went.	44.3	-45.1	37.5	116.5	80.7	33.8

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	16.1	19.9	70.9	60.1	24.4	-16.9
Durham	100.2	80.7	158.7	159.9	33.3	-14.7
York	73.6	47.3	125.4	163.8	34.3	-10.0
Peel	33.6	-2.2	94.4	90.6	59.7	17.1
Halton	41.3	-31.3	28.0	89.4	71.2	19.5
Hamilton-Went.	40.5	-45.1	37.5	117.4	79.9	33.5

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	21.4	-9.7	88.4	82.0	201.7	5.5
Durham	130.0	80.7	141.4	ERR	ERR	ERR
York	78.6	ERR	138.3	358.5	ERR	-56.5
Peel	20.3	ERR	135.8	85.8	55.7	3.8
Halton	22.5	-56.5	673.3	77.2	68.5	16.2
Hamilton-Went.	52.2	ERR	ERR	76.1	103.6	35.4

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	176390	4956	42554	22961	1603	-273
Durham	34222	85945	9969	1908	42	-7
York	71009	1924	108752	11966	229	-15
Peel	49740	290	7823	123576	5604	338
Halton	13687	4	771	18021	56536	1886
Hamilton-Went.	2306	-36	81	2193	17562	33646

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	69285	4835	34912	20459	1192	-283
Durham	25349	77018	9923	1908	42	-7
York	54293	1871	97607	11721	229	-3
Peel	38388	290	7600	108991	5501	342
Halton	9762	14	422	17823	51064	1850
Hamilton-Went.	1298	-36	81	2156	16967	26503

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	91642	68	7408	2503	392	10
Durham	8841	3520	46	0	0	0
York	16606	0	4670	245	0	-12
Peel	11313	0	223	8623	121	-4
Halton	3924	-10	349	145	2042	36
Hamilton-Went.	1008	0	0	37	521	4381

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	23.4	55.3	79.7	45.9	41.4	-20.9
Durham	111.0	114.6	210.4	128.7	32.6	-10.3
York	108.8	89.8	199.8	193.9	57.4	-20.5
Peel	55.0	46.1	108.7	97.7	94.4	23.5
Halton	72.1	2.0	90.9	102.7	111.0	19.6
Hamilton-Went.	59.0	-35.3	34.9	99.3	116.2	29.2

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	16.2	56.1	76.4	44.2	32.5	-22.9
Durham	99.8	114.2	210.7	128.7	32.6	-10.3
York	100.8	88.2	198.3	191.6	57.4	-6.0
Peel	53.7	46.1	107.8	98.1	95.5	24.2
Halton	73.7	8.0	52.6	102.8	111.2	19.7
Hamilton-Went.	49.3	-35.3	34.9	99.7	115.2	28.9

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	32.5	22.0	100.2	67.4	225.3	13.7
Durham	163.3	122.3	158.6	ERR	ERR	ERR
York	147.4	ERR	230.2	462.3	ERR	-52.2
Peel	59.8	ERR	150.7	97.7	86.4	-15.4
Halton	68.5	-43.5	775.6	91.8	108.0	16.2
Hamilton-Went.	79.1	ERR	ERR	80.4	142.3	30.4

SCENARIO 2 SUMMARY OUTPUT

Scenario #2 for 2001 and 2011

Table 1 : Number of Trips for All Purposes, 24 Hours
Note : Trips do NOT include walk trips.

Regional Municipality	Trips			Mode Split (% auto)		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1747407	1979097	2003558	70.3	72.7	72.5
Durham	276293	474488	572398	90.1	87.9	87.4
York	304073	582299	733129	86.7	88.0	87.0
Peel	494685	822962	906579	87.4	87.0	86.6
Halton	254240	355429	430261	91.1	89.5	88.7
Hamilton-Went.	352669	414380	417644	86.2	86.4	86.6

Regional Municipality	Auto Trips			Transit Trips		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1227681	1438035	1451886	519727	541062	551672
Durham	248853	417180	500108	27440	57308	72290
York	263765	512678	637729	40308	69621	95400
Peel	432572	715786	785097	62112	107176	121482
Halton	231615	318265	381741	22625	37164	48520
Hamilton-Went.	303983	358063	361548	48686	56317	56096

Trip Rates for 24-Hour Work Trips : Scenario #2

Total 24-Hour Work Trips All Modes

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.409	0.436	0.428	0.461	0.503	0.502	0.358	0.374	0.360
Durham	0.354	0.429	0.417	0.440	0.505	0.490	0.268	0.352	0.344
York	0.372	0.429	0.417	0.454	0.506	0.488	0.293	0.351	0.344
Peel	0.402	0.443	0.415	0.465	0.512	0.485	0.339	0.374	0.346
Halton	0.371	0.431	0.410	0.452	0.514	0.488	0.290	0.350	0.333
Hamilton-Went	0.323	0.415	0.407	0.392	0.495	0.490	0.257	0.339	0.328

Total 24-Hour Work Trips, Auto Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.249	0.274	0.267	0.330	0.367	0.363	0.172	0.189	0.180
Durham	0.312	0.377	0.366	0.402	0.458	0.444	0.225	0.295	0.288
York	0.324	0.374	0.361	0.414	0.459	0.441	0.236	0.288	0.281
Peel	0.342	0.384	0.359	0.420	0.467	0.441	0.265	0.300	0.277
Halton	0.328	0.388	0.366	0.412	0.477	0.450	0.245	0.301	0.285
Hamilton-Went	0.263	0.340	0.335	0.343	0.437	0.434	0.186	0.247	0.241

Total 24-Hour Work Trips, Transit Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.137	0.140	0.139	0.110	0.116	0.118	0.163	0.163	0.158
Durham	0.026	0.034	0.033	0.023	0.030	0.029	0.029	0.039	0.038
York	0.038	0.041	0.041	0.032	0.035	0.035	0.045	0.048	0.047
Peel	0.048	0.044	0.043	0.037	0.033	0.033	0.059	0.054	0.052
Halton	0.030	0.027	0.027	0.031	0.024	0.025	0.029	0.029	0.029
Hamilton-Went	0.038	0.047	0.045	0.028	0.034	0.033	0.046	0.060	0.057

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	52018	1790	46039	35215	1442	54
Durham	33354	72606	10977	2987	56	10
York	50894	1178	82800	12815	222	3
Peel	22604	77	6369	140607	3968	693
Halton	4029	-71	624	17826	43938	4209
Hamilton-Went.	396	-59	8	2007	13566	45356

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	30161	1808	38120	32167	1090	43
Durham	26114	64880	10917	2987	56	10
York	41280	1137	73930	12592	222	12
Peel	20411	77	6176	123626	3904	688
Halton	3665	-56	206	17644	39435	4118
Hamilton-Went.	212	-59	8	1987	13066	35554

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	21588	-51	7631	3050	330	11
Durham	7231	3157	60	0	0	0
York	9526	0	3821	223	0	-9
Peel	2166	0	193	9964	78	5
Halton	363	-15	418	135	1663	91
Hamilton-Went.	184	0	0	20	434	6021

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986
for year 2001 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	6.9	20.0	86.3	70.4	37.2	4.1
Durham	108.2	96.8	231.6	201.4	43.4	14.7
York	78.0	55.0	152.1	207.7	55.6	4.1
Peel	25.0	12.2	88.5	111.2	66.8	48.2
Halton	21.2	-35.7	73.6	101.6	86.3	43.8
Hamilton-Went.	10.1	-57.8	3.4	90.9	89.7	39.3

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	7.1	21.0	83.4	69.5	29.7	3.5
Durham	102.8	96.2	231.8	201.4	43.4	14.7
York	76.6	53.6	150.2	205.9	55.6	24.0
Peel	28.6	12.2	87.6	111.3	67.8	48.7
Halton	27.7	-31.8	25.7	101.8	85.8	43.9
Hamilton-Went.	8.1	-57.8	3.4	91.9	88.7	38.8

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	7.7	-16.5	103.2	82.2	189.7	15.1
Durham	133.6	109.7	206.9	ERR	ERR	ERR
York	84.5	ERR	188.3	420.8	ERR	-39.1
Peel	11.4	ERR	130.4	112.9	55.7	19.2
Halton	6.3	-65.2	928.9	85.4	88.0	41.0
Hamilton-Went.	14.4	ERR	ERR	43.5	118.6	41.8

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	61852	2512	46203	25494	1585	-109
Durham	43493	106325	15565	3093	88	15
York	77012	1550	132299	14945	366	11
Peel	43491	210	7066	150544	6201	810
Halton	10956	-36	903	22174	67750	3905
Hamilton-Went.	888	-59	7	1754	20060	38600

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	34257	2504	38407	23263	1245	-113
Durham	34094	94635	15491	3093	88	15
York	61984	1490	117413	14655	366	16
Peel	36516	210	6898	132681	6076	810
Halton	8651	-21	453	21913	60464	3821
Hamilton-Went.	513	-59	7	1730	19323	30211

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	25839	-30	7518	2232	309	4
Durham	9382	4904	74	0	0	0
York	14898	0	6384	290	0	-5
Peel	6939	0	168	10561	143	0
Halton	2304	-15	450	187	2706	84
Hamilton-Went.	375	0	0	24	640	5159

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of percentage of trips for both sexes

Regional Municipality	All Modes Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	8.2	28.0	86.6	51.0	40.9	-8.3
Durham	141.1	141.7	328.4	208.6	68.2	22.1
York	118.0	72.4	243.0	242.2	91.7	15.1
Peel	48.1	33.4	98.2	119.1	104.4	56.3
Halton	57.7	-18.1	106.5	126.3	133.0	40.7
Hamilton-Went.	22.7	-57.8	3.0	79.4	132.7	33.5

Note : All Modes include walk trips.

Regional Municipality	Auto Mode Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	8.0	29.1	84.0	50.3	33.9	-9.2
Durham	134.3	140.3	328.9	208.6	68.2	22.1
York	115.0	70.2	238.5	239.6	91.7	32.0
Peel	51.1	33.4	97.8	119.4	105.5	57.3
Halton	65.3	-11.9	56.4	126.4	131.6	40.7
Hamilton-Went.	19.5	-57.8	3.0	80.0	131.2	33.0

Regional Municipality	Transit Mode Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	9.2	-9.7	101.7	60.1	177.6	5.5
Durham	173.3	170.5	255.2	ERR	ERR	ERR
York	132.2	ERR	314.6	547.2	ERR	-21.7
Peel	36.7	ERR	113.5	119.7	102.1	0.0
Halton	40.2	-65.2	1000.0	118.4	143.2	37.8
Hamilton-Went.	29.4	ERR	ERR	52.2	174.9	35.8

SCENARIO 3 SUMMARY OUTPUT

Scenario #3 for 2001 and 2011

Table 1 : Number of Trips for All Purposes, 24 Hours
Note : Trips do NOT include walk trips.

Regional Municipality	Trips			Mode Split (% auto)		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1747407	1975704	1999023	70.3	73.9	73.8
Durham	276293	477934	574154	90.1	89.7	89.4
York	304073	605683	777537	86.7	89.7	89.6
Peel	494685	840169	938176	87.4	88.3	88.0
Halton	254240	362214	440574	91.1	90.7	90.6
Hamilton-Went.	352669	418018	422671	86.2	86.7	87.0

Regional Municipality	Auto Trips			Transit Trips		
	'86	'01	'11	'86	'01	'11
Metro Toronto	1227681	1459880	1474972	519727	515824	524051
Durham	248853	428556	513203	27440	49378	60951
York	263765	543293	696749	40308	62390	80788
Peel	432572	741728	825306	62112	98441	112870
Halton	231615	328558	399112	22625	33656	41462
Hamilton-Went.	303983	362514	367758	48686	55504	54913

Trip Rates for 24-Hour Work Trips : Scenario #3

Total 24-Hour Work Trips All Modes

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.409	0.437	0.430	0.461	0.510	0.511	0.358	0.370	0.357
Durham	0.354	0.413	0.394	0.440	0.498	0.475	0.268	0.328	0.313
York	0.372	0.431	0.418	0.454	0.520	0.506	0.293	0.341	0.331
Peel	0.402	0.446	0.425	0.465	0.526	0.506	0.339	0.367	0.346
Halton	0.371	0.431	0.401	0.452	0.524	0.490	0.290	0.340	0.314
Hamilton-Went	0.323	0.416	0.409	0.392	0.502	0.499	0.257	0.334	0.323

Total 24-Hour Work Trips, Auto Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.249	0.286	0.281	0.330	0.384	0.383	0.172	0.195	0.187
Durham	0.312	0.367	0.350	0.402	0.457	0.435	0.225	0.278	0.265
York	0.324	0.382	0.370	0.414	0.477	0.462	0.236	0.286	0.277
Peel	0.342	0.389	0.371	0.420	0.483	0.464	0.265	0.296	0.278
Halton	0.328	0.391	0.362	0.412	0.489	0.455	0.245	0.295	0.270
Hamilton-Went	0.263	0.341	0.337	0.343	0.444	0.443	0.186	0.243	0.238

Total 24-Hour Work Trips, Transit Mode

Regional Municipality	Total '86	Total '01	Total '11	Male '86	Male '01	Male '11	Female '86	Female '01	Female '11
Metro Toronto	0.137	0.131	0.130	0.110	0.108	0.109	0.163	0.154	0.149
Durham	0.026	0.026	0.024	0.023	0.022	0.020	0.029	0.030	0.028
York	0.038	0.034	0.033	0.032	0.029	0.028	0.045	0.039	0.037
Peel	0.048	0.040	0.039	0.037	0.031	0.030	0.059	0.050	0.048
Halton	0.030	0.023	0.022	0.031	0.020	0.020	0.029	0.025	0.024
Hamilton-Went	0.038	0.047	0.045	0.028	0.034	0.033	0.046	0.058	0.055

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	9883	8393	62311	54089	4217	672
Durham	13225	87109	8143	2777	90	30
York	31236	2813	98920	15667	435	29
Peel	3377	258	8658	156502	7422	1402
Halton	-1695	-30	425	15634	51404	4786
Hamilton-Went.	-1099	-56	0	1421	12272	49018

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	15855	8243	52461	49610	3565	630
Durham	10763	77903	8103	2777	90	30
York	26494	2746	89073	15421	435	32
Peel	5636	258	8435	137036	7286	1379
Halton	-410	-18	148	15483	46340	4685
Hamilton-Went.	-739	-56	0	1408	11825	38733

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	-2697	62	9497	4473	602	42
Durham	2459	3639	40	0	0	0
York	4685	0	4101	246	0	-3
Peel	-2281	0	223	11313	156	23
Halton	-1286	-12	277	107	1876	101
Hamilton-Went.	-360	0	0	13	387	6292

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2001 in terms of percentage of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	1.3	93.6	116.8	108.1	108.9	51.4
Durham	42.9	116.1	171.8	187.3	69.8	44.1
York	47.8	131.3	181.7	253.9	109.0	39.7
Peel	3.7	41.0	120.3	123.8	125.0	97.4
Halton	-8.9	-15.1	50.1	89.1	100.9	49.8
Hamilton-Went.	-28.1	-54.9	0.0	64.4	81.2	42.5

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	3.7	95.7	114.7	107.2	97.1	51.1
Durham	42.4	115.5	172.0	187.3	69.8	44.1
York	49.2	129.4	180.9	252.1	109.0	64.0
Peel	7.9	41.0	119.6	123.3	126.5	97.6
Halton	-3.1	-10.2	18.4	89.3	100.9	49.9
Hamilton-Went.	-28.1	-54.9	0.0	65.1	80.3	42.3

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	-1.0	20.1	128.5	120.5	346.0	57.5
Durham	45.4	126.5	137.9	ERR	ERR	ERR
York	41.6	ERR	202.1	464.2	ERR	-13.0
Peel	-12.1	ERR	150.7	128.2	111.4	88.5
Halton	-22.5	-52.2	615.6	67.7	99.3	45.5
Hamilton-Went.	-28.2	ERR	ERR	28.3	105.7	43.7

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of number of trips for both sexes

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	10177	13189	69366	44705	5320	471
Durham	15904	122657	11754	2525	126	36
York	49249	4373	154567	18751	683	35
Peel	19327	718	10569	175101	12030	1544
Halton	1174	54	642	16804	78164	4180
Hamilton-Went.	-860	-45	7	1230	19452	42485

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	13718	12879	58166	41012	4571	434
Durham	12949	109331	11703	2525	126	36
York	41235	4257	138426	18426	683	36
Peel	18201	718	10274	153385	11779	1531
Halton	1653	64	321	16638	70164	4089
Hamilton-Went.	-590	-45	7	1214	18741	33553

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	-1266	181	10793	3687	686	37
Durham	2950	5319	51	0	0	0
York	7926	0	6763	325	0	-1
Peel	1101	0	295	12545	263	13
Halton	-480	-10	321	116	2914	91
Hamilton-Went.	-270	0	0	16	616	5468

Table 6 : Changes in 24 Hours Work Trip O-D Flows w.r.t. 1986 for year 2011 in terms of percentage of trips for both sexe

Regional Municipality	All Modes					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	1.3	147.1	130.0	89.4	137.4	36.0
Durham	51.6	163.5	248.0	170.3	97.7	52.9
York	75.4	204.2	283.9	303.9	171.2	47.9
Peel	21.4	114.1	146.8	138.5	202.6	107.3
Halton	6.2	27.1	75.7	95.7	153.5	43.5
Hamilton-Went.	-22.0	-44.1	3.0	55.7	128.7	36.8

Note : All Modes include walk trips.

Regional Municipality	Auto Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	3.2	149.6	127.2	88.6	124.4	35.2
Durham	51.0	162.1	248.5	170.3	97.7	52.9
York	76.5	200.6	281.2	301.2	171.2	72.0
Peel	25.5	114.1	145.7	138.0	204.6	108.4
Halton	12.5	36.4	40.0	96.0	152.7	43.6
Hamilton-Went.	-22.4	-44.1	3.0	56.2	127.3	36.6

Regional Municipality	Transit Mode					
	Metro Toronto	Durham	York	Peel	Halton	Hamilt.-Went.
Metro Toronto	-0.4	58.6	146.0	99.3	394.3	50.7
Durham	54.5	184.9	175.9	ERR	ERR	ERR
York	70.3	ERR	333.3	613.2	ERR	-4.3
Peel	5.8	ERR	199.3	142.1	187.9	50.0
Halton	-8.4	-43.5	713.3	73.4	154.2	41.0
Hamilton-Went.	-21.2	ERR	ERR	34.8	168.3	37.9

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